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CHILD DEVELOPMENT

In this number there are reports of investigations of the information acquired by children; of the child's memory in relation to bodily orientation; of changes in behavior with increasing age; of the development of coördination in hand movements; of methods of studying infant reactions; and of conditions in dentition of preschool children.

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A General Information Test for Kindergarten Children[1,2]

CATHRYN A. PROBST

IN SPITE of the growing interest in the study of child development, up to the present time but few research workers have concerned themselves with the amount and types of knowledge possessed by the young child before he begins his elementary school education. Since the fundamentals of general information are acquired early, and since later instruction must be founded upon the store of knowledge previously gained by the child, some means of measuring his informational level is needed.

SURVEY OF PREVIOUS INVESTIGATIONS

In 1891 Hall (1) published the results obtained by submitting 200 five and six year old children in the Boston schools to an information test which included 49 items, having to do with such matters as parts of the body, simple geometrical forms, home and family life, familiar objects, etc. The most outstanding finding of the study was the amazing ignorance of the children regarding many of the concepts with which they were assumed to be thoroughly acquainted. Sex differences both in amount and kind of information were also found: the boys exceeded the girls in knowledge of 34 of the 49 items, but the girls were superior to the boys in knowledge of parts of the body, home and family life and similar widely diffused concepts; while the boys excelled in knowledge of the sphere, cube, pyramid, numbers, animals and other more specialized matters less common to all environments.

In addition to his own findings, Hall also reports those of several other writers. Lange found that in the city schools of Plauen only 43 per cent had seen the nearest castle. In color discrimination, black, white and red were better known colors than were green and blue, while yellow was the least familiar. Higher percentages were attained by the boys in identifying all of the seventeen subjects included in the test except that the girls rated higher in knowledge of the "dear God."

In a study made in Berlin upon 2,238 children about to enter school, the girls were inferior to the boys in knowledge of three-fourths of the concepts embodied in the test. They showed greater familiarity with objects within their immediate environment while

[1] From the Institute of Child Welfare and College of Education, The University of Minnesota.

[2] The writer wishes to acknowledge her indebtedness to Dr. Florence L. Goodenough of the Institute of Child Welfare, University of Minnesota for advice and assistance throughout the progress of this study.

the boys were better able to grasp more specialized concepts, a knowledge of which was likely to be gained through adventuring into more remote surroundings. Numbers were more readily understood by the boys, but the girls excelled in space concepts.

Repeated tests over a five year period were given by Hartmann to 1,312 children ranging in age from five and three-fourth to six and three-fourth years, in the Annaberg schools. The boys were found to excel in certain concepts referring to animals, minerals and social relations. However, the boys on the average were acquainted with only 36 of the objects considered, while the average score for the girls was 56. This finding is in apparent contradiction to results previously quoted, but it is explained by Hartmann's conclusion that while the girls excelled the boys at the beginning of their elementary education, this discrepancy became less and less until the sixth year, after which the boys took the lead. It should also be noted that Hartman's questionnaire included a greater number of items dealing with the immediate environment of the child than did those used by Hall and Lange.

Olson, whose study is reported in another book by G. Stanley Hall, "Aspects of Child Life and Education," worked with 5,600 children, cataloguing their information on 100 subjects. In this study the children were examined singly by different teachers rather than in small groups as were the subjects in the above mentioned studies. While the girls evidenced fewer clear ideas than the boys, they surpassed them in their grasp of religion, funerals, affective ideas in general, and the seasons.

Terman (2) in reporting the total score attained in an information test involving history, geography, the arts and sciences, calls attention to the consistent superiority of boys over girls throughout the entire range of chronological ages, six to fourteen years, included in this study. Considering the scores on the test as a whole, the six year old boys identified ten more items than the girls did. The largest differences in favor of the boys were apparent in history and civics. In art information, language and literature the six year old girls scored practically as high as did the boys; but in geography the boys were slightly superior to the girls.

The possibility that a difference in the nature of the items included may result in quite diverse conclusions makes any generalization regarding the various studies somewhat questionable. However, the weight of evidence appears to indicate that boys have a wider range of information than girls and that idiosyncrasies due to sex interests are present. The girls show themselves superior in comprehending the commoner elements in their environments while the boys have more specialized concepts and fewer that are widely diffused. Moreover in the earlier studies as reported by Hall the conditions and methods employed were not as well controlled nor as uniform as it would have been possible to make them. The children were tested in small groups by teachers untrained in scientific procedure. Hall acknowledges that children were almost twice as likely to profess knowledge of a con-

cept when they were in classes as when they were being tested in groups of eight or ten children.

NATURE OF THE PRESENT STUDY

This is an attempt to evaluate by means of an improved technique the amount and type of general information that young children have at their command upon entering the elementary school. Only children in the second half year of kindergarten were used as subjects in the investigation. The range of chronological ages was from 5 years 4 months to 6 years.

An objective examination was composed and given under uniform conditions. While this test is obviously not sufficiently exhaustive to show the amount of information possessed by any child, it does show with considerable accuracy how he compares with other children of his age in this respect. The greater number of items included have to do with objects fairly common in the environment of most urban children, or with those that form common topics of conversation.

DEVELOPMENT OF THE METHOD

After several hundred questions had been formulated, a preliminary test was given to determine those questions best suited to the mental attainments of the children. The items themselves were collected during several weeks of daily observation of kindergarten classes to discover what the children were most likely to be acquainted with and talk about. In addition, a number of questions were suggested by research workers in the field of child development. Questions of phraseology were decided empirically by means of a survey made upon 15 children. A tentative form was tried out individually with 3 children and necessary changes were made on the basis of the combined responses. The revised form was then tried with three other children, and the process repeated until a fifth revision which appeared to yield satisfactory results had been worked out.

After deciding upon the questions to be included in the test, these in turn were divided into eleven categories: Local Points of Interest, Time and Number, Current Topics and History, Natural Phenomena, Literature and Music, Animals, Birds and Insects, Plants and Flowers, Occupations and Industries, Household Arts, Simple Mechanics, and Games and Amusements. Two forms of supposedly equal difficulty were devised. Each form included 6 questions under each of the eleven divisions or categories, making a total of 132 questions.

As will be seen from the questionnaire which follows, both forms are as nearly equal as to content and difficulty as it was possible to make them. An attempt was made to grade the questions within each category with reference to difficulty as follows:

1. A very easy question (roughly estimated to evoke 90 per cent or better correct answers).
2. An easy question (75 per cent to 90 per cent).
3–4. Two questions of average difficulty (25 per cent to 75 per cent).
5. A difficult question (10 per cent to 25 per cent).
6. A very difficult question (less than 10 per cent).

A group of 100 children, fifty boys and fifty girls, was chosen from seven

different kindergartens on the basis of paternal occupation apportioned according to representation in the total population of Minneapolis. Table 1 describes the numerical composition of the group in terms of an occupational classification based upon the Barr Scale for Occupational Intelligence and the Taussig Industrial Classification. A description of this revised classification has been published by Florence L. Goodenough.

TABLE 1

Composition of the experimental group

OCCUPATIONAL GROUP	NUMBER OF BOYS	NUMBER OF GIRLS	TOTAL	TOTAL POPULATION OF MINNEAPOLIS
				per cent
I. Professional	3	3	6	5.4
II. Semi-professional and managerial	3	3	6	6.3
III. Clerical and skilled trades	19	19	38	37.3
IV. Semi-skilled trades and minor clerical	12	12	24	24.3
V. Slightly skilled	7	7	14	14.9
VI. Unskilled labor	6	6	12	11.8
Total boys	50			
Total girls		50		
Total for both sexes			100	

EXPERIMENTAL CONDITIONS

The writer administered both forms of the test always in the A-B order, within a time interval of 7 days. Each child was tested individually during regular school hours in a private classroom, where there was little or no chance for disturbance. The examiner always recorded the verbatim responses; and, although no time limit had been set the time consumed was noted to the nearest whole number of minutes. There was no excessive urging nor additional help beyond the repetition of the question or, in cases of doubtful responses, further questioning, such as, "Tell me what you mean." or "Explain" or "What do you mean by that?" As a rule, the children were very coöperative, regarding the examiner as one of the teachers and looking upon the procedure as a part of their school program. The writer did her best to cultivate a conversational tone of voice and to ask the questions in a casual manner.

When Form A of the test was given, three questions noted on the examination sheet were used as an introductory exercise. These were not scored. If the child failed to respond to these questions the answers were supplied by the examiner.

TYPES OF RESPONSE CREDITED

Such questions as the number of wings a butterfly has, the time it is at midnight, the color of a crow, the number of pennies in a dime, etc., obviously, are easy to score and need no further comment. For the remainder a few general principles will indicate the nature of the credits allowed:

1. In items comparable to "What is Dayton's?" "What is WCCO?" the specific responses of "store" and "radio station" were not required but any reply showing knowledge of Dayton's as a place where you buy things or any connection of WCCO with radio was credited.

2. For items such as "Who is Andy Gump, Lindbergh, Dempsey, Coogan, Hoover, Skeezix, Coolidge, Joesting and Smith," any distinguishing characteristics were credited. For Lindbergh, the association with airplanes or flying constituted an adequate answer.

3. In such questions as "From what does leather come?" "Where does coal come from?" the origin had to be known. For the first of these, "cow" or any other animal from whose skin leather can be made was credited as well as "animals."

4. The items on carpenters and plumbers were credited as answered correctly if any activity that is ordinarily associated with their occupations was given.

5. Whenever the answer was ambiguous, a further question asking for an explanation usually gave sufficient basis for deciding whether credit was to be allowed.

6. The following is a list of items offering more possibilities of variation in response and for which there are necessary restrictions as to credit.

What is the name of a lake in Minneapolis?

Any lake immediately surrounding Minneapolis but not necessarily within the city limits was credited. Minnetonka, perhaps, its best known lake, was always accepted as a legitimate reply, although it is near Minneapolis rather than in it.

What is the Mississippi?

River, only, was credited.

Of what is snow made?

Water, rain or water, rain, ice.

What are the clouds made of?

Rain, snow, smoke, water.

On what part of the violin do you play?

Strings, rubber bands, wires.

How do you play a cornet (or a saxaphone)?

Blowing or playing with your mouth was required.

What does a cat scratch with?

Paws, claws, nails on paws, scratchers on paws, nails on feet.

What color is wheat when it is ripe?

Yellow, golden, tan, golden brown, brown.

What is butter made from?

Milk and cream were both allowed.

How are trees made into boards?

Saw, saw-mill, saw-machine.

Of what is ice made?

Water, frozen water, rain.

Types of incorrect response

The variety and quality of the incorrect responses provide the most interesting and colorful phase of an analysis such as this. One of the outstanding characteristics of the young child is his tendency to absorb the color of his surroundings and to manifest such an inclination by his ingenuous questions or remarks. Jacky Coogan is "the boy on Lawrence's sweater" or "makes shoes downtown;" the nearest city is "Southeast;" Al Smith "made our sidewalk," "He's our preacher," or "he's out at Ham Lake," where the family

spent the summer. One boy could not give the name of any newspaper but ended a vivid description of a recent sensational murder case with the convincing statement, "That's the paper we take!"

Euphonic analogy and slang associations account for a number of incorrect responses. A carpenter fixes carpet sweepers or repairs cars; energine is put in the radiators of cars; the Great Northern is the North Star; butter is made from buttermilk or butterflies make it; plants, seeds, and flowers are manufactured in the Ford Plant; baking powder is what ladies use on their faces. A plumber plumbs, pulls out plums or sells plumbers. Other mistakes are the result of mere word associations. Dempsey-Tunney was sometimes given in answer to the question "Who is Dempsey," Butter is made from oleomargerine or Land O'Lakes; beans grow in gardens but bees make them. More or less intimate associations with certain phenomena or common characteristics of color or form produce such misconceptions as snow being made from sand "because sand is grey." Juvenile literature is responsible for replies similar to: "Clouds are made of animals" the result of hearing a verse in which children see animals in the clouds; and "butter is made from tigers," which is true of the tigers in the story of Little Black Sambo.

While such influences are apparent in a variety of incorrect responses, there are others of which the origin is less easily explainable. According to the careful elaboration of one child, coal is made at the North Pole by God. He ships it out to the people on earth who are still in need of such mortal comforts. The heat in the summer time comes from stoves at the South Pole. When the stoves are turned off it's cold. A thermometer tells how to be good or how much you weigh or "no danger—railroad crossing." Butter is made from yellow sunshine or from a windmill. Paper is made from iron, bread, dough or glue. A man who raises corn or wheat is called a bachelor.

RESULTS

Reliability of the total score

Reliability has been computed by correlating the scores made on Form A against those made on Form B. It will be recalled that Form A was always administered first. The form-versus-form method of computing reliability is commonly regarded as a more rigorous test of consistency of measurement than either the test-retest or the split-scale method. The test-retest method is likely to yield results which are spuriously high due to the operation of memory factors; the split scale method is likely to be similarly affected, particularly in the case of young children, by the operation of such factors as shyness, negativism or fatigue which are incident to the immediate situation but not pertinent to the general field of inquiry. Both these sources of error are avoided by the method used in this investigation. The results are shown in table 2.

The total scores on the separate parts of the test for each individual child are very similar. One point was allowed for every response credited, so that a perfect score on either form was 66 and a perfect combined score, 132. The range of scores on the two forms is

almost identical; in A from 15 to 55, in B from 14 to 52 points. The mean on Form B is 1.6 points higher than that on Form A. Whether this is the result of practice or of a slight difference in the difficulty of the two forms cannot be determined from our data. The standard deviations of the two forms are also very similar. According to the combined scores the average child possessed a knowledge of 71.6 of the concepts enumerated in the test. Among the 13 highest scores, 11 were earned by boys and only 2 by girls.

Reliability of the separate categories

Table 3 gives the reliability of the individual categories, their means and standard deviations, and the ratio of the actual difference between means to the standard error of the difference for the sexes and for the upper and lower halves of the occupational groups.

As was to be expected, these reliability coefficients are much lower than that of the total scale. For our group of subjects, Category VI, (animals,

TABLE 2

Reliability of the information test

	PEARSONIAN r	P.E.	MEAN	S.D.
Form A vs. Form B	.94	.008	(A) 36.2	9.8
Combined scores (Spearman Brown Formula)	.97	.003	(B) 37.8	9.5

TABLE 3

Reliability of the separate categories

Differences between occupational classes and between boys and girls

CATEGORY	RELIABILITY				MEAN					
	Uncorrected	Spearman Brown	Mean total	S.D. total	Upper half	Lower half	D/σD	Girls	Boys	D/σD
VIII. Local	.55	.71	5.8	2.5	7.5	5.0	5.3	5.2	6.5	2.8
II. Time and number	.69	.83	6.6	2.0	7.0	6.3	1.9	6.7	6.7	.1
III. Current topics and history	.65	.78	5.4	2.1	6.3	4.6	4.7	5.0	5.9	2.3
IV. Natural phenomena	.29	.45	6.7	1.7	7.6	5.8	6.2	6.7	6.6	.3
V. Literature and music	.52	.68	6.3	2.1	7.1	5.5	3.6	6.1	6.8	1.4
VI. Animals, birds and insects	.80	.89	6.7	1.7	7.4	6.0	4.7	6.4	7.0	1.7
VII. Plants and flowers	.37	.54	6.5	2.6	7.6	5.6	4.2	6.4	6.6	.4
VIII. Occupations and industries	.62	.77	7.3	2.4	8.6	6.1	4.7	6.9	7.7	1.8
IX. Household arts	.33	.50	7.1	2.2	8.1	6.9	3.5	7.1	7.0	.2
X. Mechanical	.65	.79	6.7	2.5	8.2	5.5	6.8	5.9	7.5	3.5
XI. Games and amusements	.61	.76	4.4	2.1	5.0	3.7	3.3	3.7	5.2	3.8
Composite A and B	.94	.97	71.6	19.1	80.0	63.0	4.9	67	78	2.9

birds and insects) was most reliable, while Categories VII (plants and flowers) and IV (natural phenomena) showed least agreement between the two forms.

Correlation with the Detroit kindergarten test

The Pearson product moment correlation between the combined scores or the two forms of the information test and the Detroit intelligence test for kindergarten children was $+.64 \pm .04$. A number of factors which tended to lower this correlation should be noted. The Detroit test is supposed to be given to all pupils during the first and second months of school, but in some cases it was postponed for as much as four or five months. Since age-norms for this test had not been published at the time of this study, it was not possible to correct for discrepancies in age resulting from irregularities in the time of administration. Each of the cases was examined by his respective teacher. The tests were given by the kindergarten teachers, and it is doubtful whether the standardized procedure was strictly followed in all cases. In one instance, a teacher is known to have changed a certain part of the test which she thought unfair to the child. The mean Detroit score for the group was 18.9 which corresponds closely to the mean scores for other kindergartens in the city. It is of interest to note that the scores made by a pair of identical twins differed by two points on the Detroit test and three points in combined score on the information test. Since the range of scores is much greater in the information test than on the Detroit test the resemblance in information is closer than that indicated by the Detroit test.

Average time for administration

The average time for giving Form A was 19 minutes, for giving Form B, 17 minutes, making the total time consumption for both forms, 36 minutes. A correlation of $+.51$ between time on the first and time on the second occasion shows that there is some consistency in the speed in which the child reacts to the questions from occasion to occasion.

TABLE 4

Percentile distributions for the composite scores according to occupational groups and sex

PERCENTILE	OCCUPATIONAL GROUP		SEX	
	Upper half	Lower half	Girls	Boys
10	52.8	36.5	39.5	51.2
20	65.9	45.9	48.5	61.2
30	72.5	54.5	57.0	69.5
40	77.5	59.8	62.3	73.1
50	81.2	63.8	67.0	76.6
60	83.9	69.5	75.7	80.2
70	90.3	75.3	80.9	83.8
80	94.5	79.5	84.5	92.8
90	102.–	84.5	90.8	101.2
95	106.4	88.7	93.9	105.3
100	107	102	107	107

Occupational group and sex differences

A comparison of total composite scores on the first three with the last three occupational groups gives evidence of the general superiority of the former, the mean of the two differing by 17 points and the ratio between the actual difference and the standard error of the difference being 4.9. There is very little difference in the standard deviations for the upper and

TABLE 5

Percentage of successes on individual items by occupational group and sex

	OCCUPATIONAL GROUPS		SEXES		
	I, II, III	IV, V, VI	Girls	Boys	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Preliminary Exercise (not scored):					
1. Tell me the name of a street. (If no response, On what street do you live?)					
2. What is a robin?					
3. Of what flowers can you tell me the name?					
Category I. Local Points of Interest:					
1. Tell me the name of a Minneapolis newspaper	90	80	80	90	85
2. What is the name of a lake in Minneapolis.	40	14	24	30	27
3. What is the Mississippi	78	78	76	80	78
4. What is Hennepin Avenue	54	50	54	50	52
5. What is the Great Northern	46	32	30	48	39
6. What is W. C. C. O	68	44	50	62	56
1. What is Dayton's	92	92	96	88	92
2. What large city is closest to Minneapolis	42	16	18	40	29
3. What do they make in the Ford plant	54	48	42	60	51
4. What do people go to look at in the Art Gallery	8	2	4	6	5
5. In what city is Minnehaha Falls	52	36	32	56	44
6. Tell me the name of a hotel in Minneapolis	26	6	10	22	16
Total per cent on all 12 items	54.2	41.5	43	52.7	47.8
Category II. Time and Number:					
1. How many pennies in a dime	24	20	18	26	22
2. What time of year do flowers grow outdoors	100	98	100	98	99
3. What time of year is the weather cold	96	88	92	92	92
4. How many eggs in half a dozen	10	14	12	12	12
5. What day comes after Sunday	84	66	76	74	75
6. What time or what o'clock is it at noon	28	32	22	38	30
1. How many pennies in a nickel	40	34	40	34	37
2. How many hands has a clock	96	92	94	94	94
3. What time of the year is the weather hot.	98	80	90	88	89
4. How many eggs in a dozen	18	6	8	16	12
5. What day comes after Saturday	88	84	90	82	86
6. What time or what o'clock is it at midnight	24	20	24	20	22
Total per cent on all 12 items	58.8	52.8	55.4	56.2	55.8

TABLE 5—*Continued*

	OCCUPATIONAL GROUPS		SEXES		
	I, II, III	IV, V, VI	Girls	Boys	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Category III. Current Topics and History:					
1. Who is Andy Gump	90	58	80	68	74
2. What did Lindbergh do	90	84	80	94	87
3. Who was the first president	68	42	54	56	55
4. Who is Dempsey	62	64	46	80	63
5. Who is Jacky Coogan	24	20	16	28	22
6. Who is Herbert Hoover	0	0	0	0	0
1. Who is Skeezix	90	72	80	82	81
2. What are the colors in the flag	100	90	94	96	95
3. What people lived in America before the white men did	36	8	14	30	22
4. Who is Joesting	14	2	4	12	8
5. Who is Coolidge	56	20	34	42	38
6. Who is Al Smith	2	0	0	2	1
Total per cent on all 12 items	52.7	38.3	41.7	49.4	45.5
Category IV. Natural Phenomena:					
1. What shape is the sun	96	74	84	86	85
2. Of what is snow made	80	70	72	78	75
3. Where do you sometimes see a rainbow	80	62	68	74	71
4. What makes it warm in the summer time	98	84	94	88	91
5. Where does the sun set in the evening	16	8	10	14	12
6. What are clouds made of	34	34	34	34	34
1. Where are the clouds	100	98	98	100	99
2. Of what is ice made	96	82	90	88	89
3. What makes it light in the daytime	92	72	86	78	82
4. What shape are snowflakes	14	2	8	8	8
5. Where does the sun rise in the morning	40	26	38	28	33
6. What is lightning made of	10	0	4	6	5
Total per cent on all 12 items	63	51	57.2	56.8	57
Category V. Literature and Music:					
1. What colors are the keys on a piano	92	76	82	86	84
2. Whom was Red Riding Hood going to see	68	48	54	62	58
3. What did Cinderella lose at the ball	50	26	36	40	38
4. On what part of the violin do you play	52	40	38	54	46
5. Who was Hiawatha	12	2	6	8	7
6. How do you play a cornet	28	20	18	30	24
1. What did Jack and Jill do	96	92	96	92	94
2. With what do you play a drum	96	92	92	96	94
3. When the three bears came home, whom did they find in bed	92	78	84	86	85

TABLE 5—*Continued*

	OCCUPATIONAL GROUPS		SEXES		
	I, II, III	IV, V, VI	Girls	Boys	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
4. What was the name of the boy who climbed the Beanstalk	58	30	36	52	44
5. What was Cinderella's coach or carriage made of	16	6	10	12	11
6. How do you play a saxaphone	54	44	34	65	49
Total per cent on all 12 items	59.5	46.2	48.8	56.8	52.8
Category VI. Animals, Birds, Insects:					
1. How many legs has a horse	100	100	100	100	100
2. What does a cat scratch with	98	96	98	96	97
3. From what are little chickens hatched	74	52	60	66	63
4. What do bees make that we eat	74	44	52	66	59
5. A baby dog is called a puppy; what is a baby cow called	32	20	20	32	26
6. What do we call a butterfly before it becomes a butterfly	30	8	10	28	19
1. What do we drink that we get from a cow.	100	98	98	100	99
2. What color is a crow	40	26	30	36	33
3. A bird flies in the air; what does a fish do in the water	94	80	84	90	87
4. How many horns has a cow	84	90	88	86	87
5. A baby cow is called a calf; what is a baby horse called	12	12	10	14	12
6. How many wings has a butterfly	4	14	8	10	9
Total per cent on all 12 items	61.8	53.3	54.8	60.3	57.5
Category VII. Plants and Flowers:					
1. What do apples grow on	100	94	94	100	97
2. What color are buttercups	38	22	32	28	30
3. What color is wheat when it is ripe	40	30	38	32	35
4. How many stones in a peach	80	64	78	66	72
5. What do we call the part of the plant underground	42	22	22	42	32
6. What do we eat that grows on vines	36	22	30	28	29
1. What must we plant to have flowers	98	92	92	98	95
2. What color are dandelions	80	60	74	66	70
3. What do we call a flower before it opens.	50	22	34	38	36
4. What color is an apple before it is ripe.	74	58	68	64	66
5. What is the outside of a tree called	42	10	18	34	26
6. What do we eat that grows under the ground	76	42	56	62	59
Total per cent on all 12 items	63	44.5	53	54.5	53.7

TABLE 5—*Continued*

	OCCUPATIONAL GROUPS		SEXES		
	I, II, III	IV, V, VI	Girls	Boys	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Category VIII. Occupations and Industries:					
1. Who makes money by cutting hair	96	96	98	94	96
2. To whose office do we go to get a tooth pulled	100	90	96	94	95
3. What does a plumber do	74	46	52	68	60
4. What is butter made from	52	28	36	44	40
5. What is a shoe made of	90	68	76	82	79
6. Where does coal come from	36	28	30	34	32
1. Who brings letters to the house	100	96	100	96	98
2. Who takes people's tonsils out	98	84	88	94	91
3. What do we call a man who raises corn and wheat	64	50	50	64	57
4. What does a carpenter do	62	58	42	78	60
5. Where does wood come from	80	58	54	84	69
6. What is paper made from	32	18	22	28	25
Total per cent on all 12 items	73.7	60	62	71.7	66.8
Category IX. Household Arts:					
1. What do we use to cut cloth	100	100	100	100	100
2. From what animal do we get bacon	28	22	24	26	25
3. What is the outside of an egg called	80	60	78	62	70
4. What is a vacuum cleaner used for	98	90	92	96	94
5. From what does leather come	24	10	16	18	17
6. From what do we get wool	46	42	42	46	44
1. What do you use to cut meat	100	100	100	100	100
2. What do you put with the lemon juice to make lemonade	86	78	82	82	82
3. How do we get water out of clothes before hanging them up to dry	96	84	86	94	90
4. For what is baking powder used	92	76	82	86	84
5. What is the yellow part of an egg called	40	20	34	26	30
6. From what do we get cotton	16	6	4	18	11
Total per cent on all 12 items	67.2	57.3	61.6	62.9	62.2
Category X. Simple Mechanics:					
1. What do you use to put a screw into wood	78	72	62	88	75
2. What do you see on the ground that trains run on	100	96	96	100	98
3. What is the brake on an automobile for	62	48	38	72	55
4. How are trees made into boards	30	8	10	28	19
5. What is a thermometer for	74	26	42	58	50
6. Gas or gasoline makes an automobile go; what makes a streetcar go	20	4	6	18	12

TABLE 5—*Concluded*

	OCCUPATIONAL GROUPS		SEXES		
	I, II, III	IV, V, VI	Girls	Boys	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
1. What do you use to put a nail into wood.	98	98	96	100	98
2. What do you use a saw for.....	100	100	100	100	100
3. What is sandpaper for.....	58	32	44	46	45
4. How can you get to the top floor of a building without walking.....	66	42	54	54	54
5. What makes a sail-boat go.....	60	30	32	58	45
6. What do we put in the radiators of automobiles.....	56	50	50	56	53
Total percentage on all 12 items.....	66.8	59.7	52.5	64.8	58.7
Category XI. Games and Amusements:					
1. How do you play leapfrog.....	32	10	18	24	21
2. What do people fish with.....	98	94	92	100	96
3. What must you not do in tin-tin.....	0	2	2	0	1
4. On what do people play hockey in the wintertime.....	64	56	46	74	60
5. In what game do you have a king-row...	10	10	2	18	10
6. In what game do you have a touchdown.	40	16	14	42	28
1. What do we use to play croquet.....	42	24	22	44	33
2. What are skiis made of.....	94	90	94	90	92
3. What must you have to play anty-over..	4	10	6	8	7
4. What do people play bridge with.....	48	30	42	36	39
5. In what game do you use a racket.....	34	18	18	34	26
6. In what game do you have a home run..	26	26	8	44	26
Total per cent on all 12 items.....	41	32.2	30.3	42.8	36.5

lower halves of the occupational groups; for the former it is 17.8 and for the latter, 16.5. As a whole, the boys exceed the girls in number of successes, the average boy having a knowledge of 10 more items than the average girl. In this instance, the ratio between the standard error of the difference and the actual difference between means is 2.85. Whatever superiority on entire categories exists is always in favor of the boys and invariably in favor of the upper half of the industrial classification. Individual items occasionally show a larger percentage of passes for the girls; this is also true of the lower occupational groups. In these cases, however, the superiority is so slight as to be practically negligible.

Table 4 presents comparisons between the two divisions of the occupational groups and between the sexes in the form of percentile scores. As is evident from table 3, the discrepancies between the means for the sexes on the separate categories are in some instances very small; those between the upper and lower halves of the occupa-

tional levels, although not always significant, appear more consistently and are more marked.

Percentages of success on individual items

Table 5 shows, for the upper and lower halves of the occupational distribution and for the sexes separately, the percentage of cases succeeding with each individual item in the two forms. Each of these sub-groups includes exactly 50 cases.

Analysis of successes on individual items

A small number of items show about an equal number of successes for both divisions of the occupational groups; others show little or no sex difference, while a majority of them gave evidence of considerable difference between socio-economic groups and a somewhat smaller proportion indicate a dissimilarity in the type of information likely to be possessed by the two sexes.

The time of year that flowers grow outdoors, the number of eggs in a dozen, the day of the week after Saturday, the time it is at midnight, and most of the other questions in the Time and Number subdivision evoke about the same number of correct answers from both sexes. Boys excel the girls by 16 per cent in naming the time at noon. Jacky Coogan, Dempsey, Lindbergh, and Coolidge are better known by the boys. The most pronounced sex difference in favor of the boys is on Dempsey. He and Lindbergh, however, are equally popular with both the upper and lower social classes. The political situation in regard to Hoover and Al Smith apparently had no significance for five year olds. This study was made during the heat of the political campaign in the fall of 1928. Most of them are completely mystified by the question, or associate the family name of Smith with that of a next-door neighbor.

In phenomena of nature, both sexes alike have approximately the same range of information, which does not coincide with the supposition that girls surpass boys in objects relatively common in their surroundings. However, in this category the upper strata of socio-economic groups exhibit quite an advantage over the lower, the ratio of the actual difference between means to the standard error of the difference being 6.16. Contrary to what has been found in previous studies, the boys do not excel the girls in all "animal" concepts, although they do so on "what bees make" the caterpillar preceding the butterfly and a "baby" cow being called a calf. Category VIII on Occupations and Industries as a whole does not display a significant advantage for either sex, but on such items as wood coming from trees, the work of a carpenter, and the nature of a plumber's occupation boys show superiority. The dentist and the doctor are equally well known in all levels of social life. It is an interesting observation that, at the age of five, boys know quite as much about the particular concepts included in the sub-group on Household Arts as do the girls.

The most distinct gap between the scores of occupational groups on any one category occurs in Mechanics and Transportation where the ratio of the actual difference in the means to the standard error of the difference is 6.78.

As is to be expected the sex distinctions in this sub-group are also quite marked. There is close agreement between the sexes in knowledge as to what can appropriately be put in the radiator of an automobile, while the result of the operation of the brake is almost twice as often understood by boys as by girls.

Category XI on Games and Amusements is unique in that the ratio of the standard error of the difference to the actual difference for the upper and lower occupational groups exceeds the corresponding difference between the sexes by only .5. This is the only instance in which such an approximation has been reached; in all the others the social group distinctions outweigh the sex differences by a much greater margin. Boys excel in naming the correct game in which touchdowns and home runs play a part and in recognizing hockey and tennis terms.

SUMMARY OF RESULTS

1. Two forms of a general information test were administered to 100 children, selected to represent approximately the various socio-economic groups within the population of Minneapolis and divided equally as to sex.

2. The test was formulated after observing kindergarten children to ascertain what topics were actually discussed by them, and by using suggestions made by trained and experienced workers in the field of preschool research.

3. The reliability of a single form of the range of information test, calculated by the Pearson product moment method, is +.94. According to the Spearman-Brown formula the reliability of the combined scores on the two forms is +.97.

4. When correlated with the Detroit Kindergarten test, there is a relationship of +.64 between intelligence and range of information, which is probably too low, due to defects in the administration of the Detroit test.

5. The total time required for giving both forms of the test is thirty-six minutes. There is a correlation of +.51 between time on Form A and time on Form B.

6. There are marked differences in range of information between upper and lower halves of the socio-economic groups, the ratio of the actual difference between means to the standard error of the difference being 4.9.

7. Sex differences in favor of the boys, while less marked than those between social classes are great enough to be reliable. The difference between the mean scores earned by the two sexes is 2.85 times the standard error of the difference. It is apparent in each of the eleven categories but is greatest in regard to mechanical information and games and amusements.

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The Expression of the Emotions in Infancy

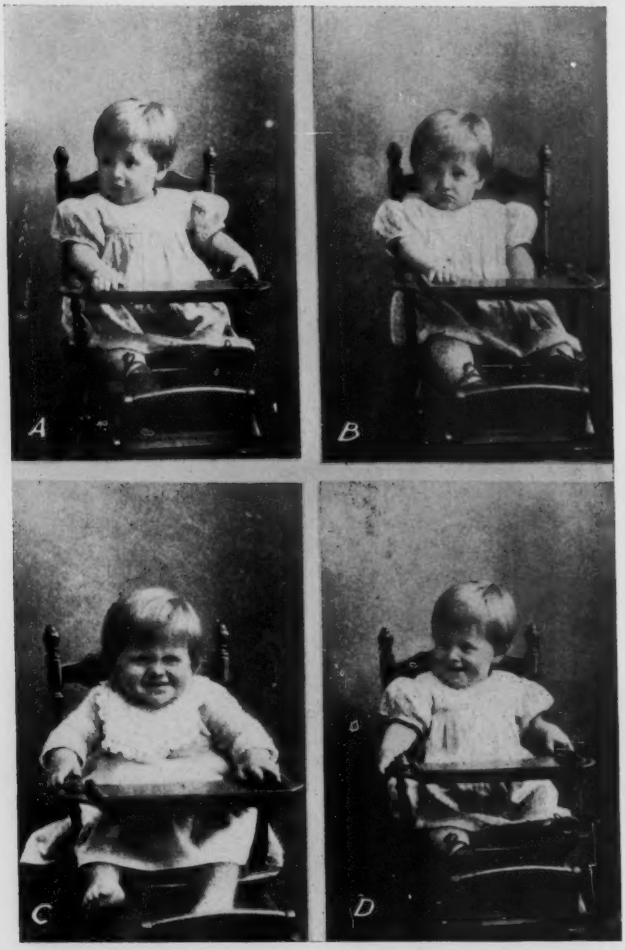
FLORENCE L. GOODENOUGH

THE question of the relative influence of "native" vs. "learned" elements in the overt expression of the emotions has been a point of controversy for several years. For a critical review and bibliography of the literature on this topic the reader is referred to Landis (2). Repeated experiments have shown that facial expression alone as shown in the ordinary still photographs of adults posed to simulate various types of emotional expression is an inadequate basis for identifying emotion, since there will usually be much disagreement among judges as to the specific emotions which the different photographs were designed to portray. Even less agreement has been found when the material consists of photographs taken in the laboratory under conditions of genuine emotional excitement or strain. These results have led some persons to the conclusion that the facial expression of emotion is in the main a learned reaction, functioning primarily as a form of language. Like other languages it may be expected to differ somewhat from one social group to another, and to become modified in various ways with the passage of time.

That the overt expression of emotion among adults may be inhibited or simulated in order to conform to social standards can hardly be doubted. It seems improbable, however, that such modification of expression either for the purpose of concealment of emotion or of conveying the idea of an emotion not actually felt will occur during the first year of life; while anyone who has ever attempted to induce a young infant to imitate an action performed in his presence may well doubt whether any large proportion of the changes in facial expression shown at those early ages have been brought about through either conscious or unconscious imitation. It seems worth while, therefore, to ascertain the extent to which adults who have had some experience with young children are able to interpret the expressive behavior of infants with sufficient accuracy to enable them to match photographs taken under conditions assumed to be provocative of some degree of emotional response with the written descriptions of the situations under which each was taken. A very careful investigation of this nature is reported by Mandel Sherman (3). Sherman's subjects, however, were new-born infants whose movements are but slightly coordinated and who, presumably, had not yet fully recovered from the shock of birth. He found that without a knowledge of the stimulus, agreement between observers as to the character of the emotion which the infant was presumably experiencing was no greater than would be expected by chance. We

are not warranted in assuming that similar results would be obtained for older infants.

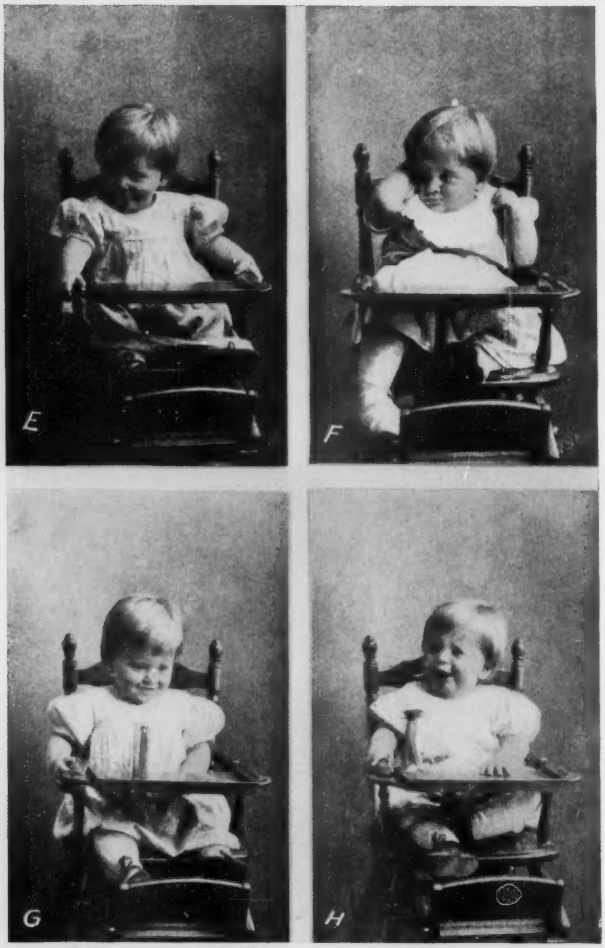
As material for this study, a series of eight pictures selected from "Die Entwicklung der Gemütsbewegungen im ersten Lebensjahre" by Martin Buchner (1) was used. These photographs, which are reproduced by permission of the publishers, are shown.



They were taken under conditions thought favorable for the eliciting of mild emotional states at an instant when the behavior of the infant sug-

gested to the observer that the anticipated emotion had been aroused. The youth of the subject (ten months) renders it highly improbable that the character of the expression had been affected to any marked degree by social tradition. For the same reason, "camera consciousness" may safely be ruled out.

Descriptions of the situations under which the photographs were taken are given by Buchner in the monograph cited, together with a brief characterization of the emotion which the child



was believed to be experiencing. These descriptions were translated literally except for the omission of certain specific references which might serve as a guide to the matching. Descriptions of four other photographs not used in the experiment were added to the list in order that the matching of the last picture would not be determined automatically by a process of elimination. A group of 68 university students enrolled in a course in child training served as judges. Each student was given a set of photographs and a mimeographed sheet of instructions as follows:

JUDGING EMOTIONS FROM PHOTOGRAPHS

Instructions: You will be given a series of photographs, labelled on the back A, B, C, D, E, F, G, H, respectively. Below is a series of paragraphs describing the situations under which the photographs were taken. In some instances the emotion which the child was believed to be experiencing is also indicated. Descriptions of four additional situations have been added, in order that the matching of the last picture will not be determined automatically by a process of elimination.

Look at the first picture (labelled A). Note the child's facial expression and bodily posture carefully. Then read through the descriptions of all situations in which the child was photographed. One of these corresponds to Picture A. When you have decided which one of the situations described would be most likely to elicit the expression shown in the picture, write the letter A in the parentheses preceding this description on the mimeographed sheet. Do the same for Picture B, then for Picture C, and so on until all the pictures have been matched. Four unmatched situations will of course be left over.

Do not omit any of the pictures. Make a judgment each time, even if you feel very uncertain as to the correct choice. State only one judgment for each picture.

Picture	*Situation*
( )	1. Satisfied smiling (with affection). He was looking at his mother who talked to him in a friendly manner.
( )	2. Astonishment (with slight displeasure). I counted loudly and emphatically as I walked toward him —'twenty, twenty-one, twenty-two, etc.' He looked me uncomprehendingly in the face.
( )	3. Fear (perhaps with dislike). A strange woman struck two blocks together, growled, and rushed suddenly up to him, frowning darkly.
( )	4. Dissatisfaction (with slight obstinacy). I had taken him up in my arms and then put him back in the chair. He wanted to come to my arms again.
( )	5. Astonishment (with auditory attention). He is listening to the ticking of a watch.
( )	6. Slight obstinacy. His mother wanted him to give her his hands, but he would not because she had just taken a toy away from him.
( )	7. Crying. He was tired of sitting and wanted to come out of his high chair into my arms.
( )	8. Astonishment (with ocular attention). A bright colored new toy clown was shown to him.
( )	9. Grimacing. The rogue is trying to wink.
( )	10. Pleasure. I rolled a shining tin can on the tray. He said softly "dai."
( )	11. Roguish smiling (with affection and tense expectation). His mother was teasing him. "Only wait, now, I'm going to catch you!"
( )	12. Anger (and displeasure). A toy has been taken away from him.

Table 1 shows the distribution of judgments for each of the eight pictures. Correct judgments are shown in the diagonal line of boxes. Of the 544 judgments 258 or 47.4 per cent are correct. The chance expectancy

is 8.3 per cent correct judgments The percentages for the different pictures vary from 14.7 for Picture A to 77.9 per cent for Picture C. Inspection of the incorrect judgments will shows that they are far from being distributed at random. In each case they tend to be concentrated within one or more situations which are as a rule closely similar to the correct one. For example, with four exceptions the errors in interpreting Picture A consist in choosing either Situation 2 or Situation 5. In both of these situations as well as in the true one *astonishment* was thought to be the predominant emotion. Likewise in the interpretation of Picture B the majority of the errors consist in selecting Situation 6 rather than 4. Again the resemblance of the two situations is striking. The only important exception to the general rule that confusions are for the most part confined to the situations in which the emotions imputed to the infant are the same or closely similar is to be found in the case of Picture F, which is most frequently attributed to Situation 6. Here the source of the confusion is probably to be found in the child's attitude of active withdrawal. Had the judgments been based upon actual observation of the child's behavior or upon moving pictures it is probable that the comparative speed of reaction (startle reflex) would have served to differentiate the two.

TABLE 1

Distribution of judgments in matching photographs and situations

PICTURE	SITUATION											
	8	4	9	1	11	3	10	7	2	5	6	12
A	10				1	1			33	21	2	
B		14				11			9	1	24	9
C	1	2	53	1	8	1		1		1		
D	1			43	16		6			2		
E	9		3	7	26		7		1	6		
F		11	1			14		1	1	5	30	5
G	12			3	1		50			1	1	
H	1	5			2		3	48				9

SUMMARY AND DISCUSSION

1. An experiment was designed to ascertain the degree of accuracy with which the expressive behavior of an infant as shown in ordinary still photographs can be identified with the descriptions of the circumstances which called it forth. A group of 68 university students enrolled in a course in child training acted as judges.

2. It was found that on the average photographs and situations were matched correctly in 47.4 per cent of the judgments, which is 5.7 times the percentage of successes to be expected by chance. Errors in matching were in the main confined to confusions between situations in which the emotions imputed to the child by the

original investigator were the same or closely similar.

3. Since the subject of the photographs was an infant of ten months, it seems improbable that the form of behavior displayed by him had been appreciably modified by social tradition or by "camera consciousness." Moreover, since the still photographs show only a single brief phase of the total pattern of expressive behavior and afford no evidence as to the speed of reaction or of its vocal accompaniments, and since the stimuli used were for the most part of a comparatively mild nature not calculated to call forth pronounced reactions, the degree of success attained by the judges takes on added significance. The findings suggest that however greatly the overt expression of emotional states may be inhibited, modified, or intentionally assumed in the social relationships of adult life, the language of expression is nevertheless built upon a core of native reaction-patterns which appear at so early an age that they can hardly be ascribed to training. It seems probable that the rôle of training and experience in the expression of the emotions consists chiefly in a process of inhibition and substitution whereby the innate reaction-patterns take on a more or less distorted form. If this hypothesis be correct, the optimum period for the study of emotional expression is to be found in early childhood, before the original patterns of response have become too extensively overlaid by the habits resulting from social experience.

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A Revised Scale for Measuring Developmental Age in Boys*

PAUL HANLY FURFEY

THE CONCEPT OF DEVELOPMENTAL AGE

IT IS a familiar and obvious fact that the behavior of the growing child changes with age. The irresponsibility of early childhood gives place to the seriousness of adult life. Play shows a wide range of development from the motor play of the infant and the dramatic play of the preschool child to the complex social recreation of the adolescent and the adult. Autistic thinking alters in character. The attitude of the growing child towards other children of the same and the opposite sex undergoes a complex sequence of changes. In fact, the whole psychology of the individual alters as he gradually grows from childhood into adulthood.

These changes may reasonably be ascribed to a volitional and an intellectual element. That is to say, the drives, or the objectives, or the plan of life, of the growing child gradually develop and are slowly transformed from year to year, while his increasing intelligence and his accumulating experience make him able to put into effect more efficiently the said drives or objectives.

* I desire to thank the many people who have aided in the preparation of this study, particularly my colleague, Dr. Thomas G. Foran.

The intelligence test movement has made possible the quantitative study of the intellectual element in conduct. We know now, at least in a general way, the effect on behavior of different degrees of mental ability. Little or no effort has been made, however, to study the changing volitional life of the growing child. The term "developmental age" has been introduced by the present writer to cover this element in conduct. It may de defined as "the progressively increasing and non-intellectual maturity of general behavior which shows itself in the growing child's play preferences, in his fantasy life, in his choice of books and movies, in his ambitions, and, in general, in his whole behavior type." In this definition no presuppositions are made as to the ultimate causes of this species of maturity. It may conceivably be due to social custom or to some factor intrinsic to the child himself, or to some combination of extrinsic and intrinsic causes. We do presuppose, however, that developmental age is not the same thing as mental age; for the term has been chosen to denote a type of maturity which is other than intellectual. As will be seen later in the present paper, the existing evidence tends to show that there is little or

no correlation between mental age and developmental age, if the effect of chronological age is eliminated.

THE PRELIMINARY SCALE

The present writer has already published a scale for measuring developmental age (1, 2, 4, 6) but it was quite frankly an experimental one. It consisted of 4 tests, two of which dealt with play preferences, one with reading preferences, and one with attitudes. As developmental age is presumably characterized by different qualities in the two sexes this scale was made applicable to boys only. The same is true of the present revised scale. The preliminary scale was given to 450 boys in the city of Washington in May, 1925.

The reliability of this preliminary scale was calculated not on the basis of the entire group but on a special group of 60 boys having a mean chronological age of 161.77 months, with a sigma of 17.29 months. By the method of split halves and the Spearman-Brown formula the reliability of the scale for this group was found to be .76. Of course, a reliability as small as this makes the scale useless except for group comparisons. It did, however, serve to show the possibilities as well as the limitations of the method.

A second defect of the preliminary scale was its extremely cumbersome scoring system. This defect may be illustrated by the scoring of test two which proved to be the most promising of the 4 tests of the scale. This test consisted of a list of activities. The child was instructed to read it through and to mark with one or two crosses respectively the activities which he liked and those which he liked very much. Each item has been assigned a weight in accordance with its value as an index of developmental age. The score for this test was fixed as 100 times the average weight of all items marked by the child. The items which he marked as liked "very much" were counted twice. Practice proved that this method of scoring was very tedious.

THE CONSTRUCTION OF THE REVISED SCALE

In constructing the new test the two defects just mentioned were kept in mind. To be satisfactory, the new test would have to have a reliability at least as high as the standard intelligence and educational tests in use in our school systems and clinics; and the scoring system should not be more difficult than those of the average group test.

In order to obtain a more satisfactory reliability the scale was considerably lengthened and more care was exercised in the selection of items. The final scale consisted of 6 tests dealing respectively with play preferences, vocational ambitions, reading preferences, and things the child would like to have, to see, and to think about.

Various improvements in the scoring system were considered. Finally a method was devised which became known as "the method of paired comparisons." As the name implies, this method consisted in presenting to the child a number of paired alternatives and he was instructed to choose one alternative in each pair. The method is illustrated in the test forms. If the child preferred the first item in

TEST 1*

"THINGS TO DO"

In each pair choose which thing you would like better to do

Would you rather:

1. Dance,	or, 2. Play "Puss in the corner"	( )
1. Play with bow and arrow,	or, 2. Shoot baskets	( )
1. Go on Scout hikes,	or, 2. Knock flies	( )
1. Play golf,	or, 2. Play soldier	( )
1. Fly kites,	or, 2. Bowl	( )
1. Play with electric trains,	or, 2. Read magazines	( )
1. Go to a club meeting,	or, 2. Play soldier	( )
1. Read novels,	or, 2. Play "Follow the Leader"	( )
1. Listen to a band playing,	or, 2. Make candy	( )
1. Work with tools,	or, 2. Play tennis	( )
1. Visit museums,	or, 2. Play with wagons	( )
1. Play "Drop the handkerchief,	or, 2. Dance	( )
1. Collect stamps,	or, 2. Play "Cowboys and Indians"	( )
1. Play with bow and arrow,	or, 2. Listen on radio	( )
1. Spin tops,	or, 2. Take pictures	( )
1 Play "Cops and thieves,"	or, 2. Go to parties	( )
1. Play the saxophone,	or, 2. Play tag	( )
1. Play "I spy,"	or, 2. Play "Parchesi"	( )
1. Go out with a girl,	or, 2. Play with Meccano	( )
1. Make model airplanes,	or, 2. Read adventure stories	( )
1. Read sport news,	or, 2. Play checkers	( )
1. Play cards,	or, 2. Play "Run, sheep, run"	( )
1. Look at toys in stores,	or, 2. Go to the movies with a girl	( )
1. Just sit around,	or, 2. Play in the sand	( )
1. Play musical instruments,	or, 2. Walk on stilts	( )
1. Play indian,	or, 2. Have "dates"	( )
1. Dance,	or, 2. Play "In and out the window"	( )
1. Play soccer,	or, 2. Play with electric trains	( )
1. Walk on stilts,	or, 2. Go to card parties	( )
1. Play basketball,	or, 2. Read the funny papers	( )
1. Make candy,	or, 2. Look at pictures	( )
1. Belong to the Boy Scouts,	or, 2. Ride in an auto	( )
1. Repair an auto,	or, 2. Read animal stories	( )
1. Erase blackboards,	or, 2. Take a walk with a girl	( )
1. Play "I spy,"	or, 2. Read magazines	( )
1. Write letters,	or, 2. Play with toys	( )
1. Drive an auto,	or, 2. Go to Scout meetings	( )
1. Do puzzles,	or, 2, Play cowboys	( )
1. Play with bow and arrow,	or, 2. Play catch	( )

* This scale is published by the C. H. Stoelting Co.

1. Repair an auto,	or, 2. Play circus	( )
1. Chew gum,	or, 2. Go out with a girl	( )
1. Pitch horseshoes,	or, 2. Play soldier	( )
1. Fly model airplanes,	or, 2. Get a letter from a girl	( )
1. Play "Cops and thieves,"	or, 2. Wrestle	( )
1. Play with a pet dog,	or, 2. Play golf	( )
1. Get a letter,	or, 2. Play with electric trains	( )
1. Go to a Wild West show,	or, 2. Go to a musical comedy	( )
1. Go visit a girl,	or, 2. Wade in the water	( )
1. Play croquet,	or, 2. Go to a dance	( )
1. Read the newspapers,	or, 2. Play circus	( )
1. Have tea with a girl,	or, 2. Play with marbles	( )
1. Play with wagons,	or, 2. Go to call on friends	( )

TEST 2

"THINGS TO BE WHEN YOU GROW UP"

In each pair choose the thing you would like better to be when you grow up

Would you rather be:

1. A stock broker,	or, 2. A blacksmith	( )
1. A cowboy,	or, 2. A banker	( )
1. A pirate,	or, 2. An astronomer	( )
1. A cartoonist,	or, 2. A judge	( )
1. A mail carrier,	or, 2. A dentist	( )
1. A fireman,	or, 2. A newspaper reporter	( )
1. A wireless operator,	or, 2. A truck driver	( )
1. A machinist,	or, 2. A king	( )
1. An electrician,	or, 2. A knight	( )
1. A soldier,	or, 2. A railroad engineer	( )
1. An author,	or, 2. A mail carrier	( )
1. An acrobat,	or, 2. An electrician	( )
1. A poet,	or, 2. An ice man	( )
1. An Indian,	or, 2. A carpenter	( )
1. A jeweler,	or, 2. A scientist	( )
1. A cowboy,	or, 2. A newspaper reporter	( )
1. A doctor,	or, 2. A policeman	( )
1. A king,	or, 2. A congressman	( )
1. A bookkeeper,	or, 2. An acrobat	( )
1. A circus performer,	or, 2. A cartoonist	( )
1. A builder,	or, 2. A chauffeur	( )
1. A civil engineer,	or, 2. A soldier	( )
1. A truck driver,	or, 2. A business man	( )
1. A knight,	or, 2. A clergyman (priest or minister)	( )

TEST 3

"BOOKS TO READ"

In each pair choose the book which you would like better to read

Would you rather read:

1. The Stampede,	or, 2. Treasure Island	( )
1. Robinson Crusoe,	or, 2. The Boys Book of Automobiles	( )
1. Apank, the Indian boy,	or, 2. The Gold Rush	( )
1. The Burning Fountain,	or, 2. Cowboys and Indians	( )
1. Uncle Wiggley Stories,	or, 2. Pee Wee Harris' Funny Bone Hike	( )
1. Danger Ahead,	or, 2. Over There	( )
1. The Freshman Hero,	or, 2. The Knight of the Silver Sword	( )
1. Gentlemen of Courage,	or, 2. The Cruel King and the Magic Ring	( )
1. The Honor of the Clan,	or, 2. The Sunbonnet Babies in Holland	( )
1. Bunny Rabbit's Friends,	or, 2. Meaning No Offense	( )
1. Sherlock Holmes,	or, 2. The Black Wolf Pack	( )
1. Robin Hood,	or, 2. The Greenwich Manor Mystery	( )
1. Captains Courageous.	or, 2. With the Indians in the Rockies	( )
1. Peter Pan,	or, 2. Rex, a Collie	( )
1. The Knight and the Dragon,	or, 2. Tom Patterson's Forward Pass	( )
1. The Pirate Prince,	or, 2. Where Men are Men	( )
1. Dauntless Heart,	or, 2. Fairy Tales of Many Lands	( )
1. Uncle Wiggley's Friends,	or, 2. Steel of the Royal Mounted	( )
1. Dan's Great Adventure,	or, 2. Cowboys and Indians	( )
1. Peter Rabbit,	or, 2. Wrongly Accused	( )
1. The Ninth Inning,	or, 2. The Indian Trail	( )
1. The Girl from Rio,	or, 2. Our Little French Cousins	( )
1. Sonny Boy,	or, 2. The Great Divide	( )
1. The Pride of the Fleet,	or, 2. Danny Brown in the Indian Camp	( )
1. The Avenger,	or, 2. Wild Animals At Home	( )
1. Grimm's Fairy Tales,	or, 2. The Girl with the Golden Hair	( )
1. Out to Win,	or, 2. Dog Heroes from Many Lands	( )

TEST 4

"THINGS TO HAVE"

In each pair choose the thing which is more fun to have

Is it more fun to have:

1. Some handkerchiefs,	or, 2. A set of toy soldiers	( )
1. A pet rabbit,	or, 2. A punching bag	( )
1. A wagon,	or, 2. A tennis racket	( )
1. A watch,	or, 2. A Scout suit	( )
1. An Indian suit,	or, 2. A pair of kid gloves	( )

1. A magic set,	or, 2. A camera	( )
1. A new hat,	or, 2. A blackboard	( )
1. A box of writing paper,	or, 2. A toy engine	( )
1. A swimming suit,	or, 2. A moving picture machine	( )
1. A cowboy suit,	or, 2. A set of golf clubs	( )
1. A brush and comb,	or, 2. A drum	( )
1. An Indian suit,	or, 2. A wallet	( )
1. A fountain pen,	or, 2. A pair of rubber gloves	( )
1. An electric train,	or, 2. A book of detective stories	( )
1. A toy wagon,	or, 2. A silk handkerchief	( )
1. A bow and arrow,	or, 2. A book of sport stories	( )
1. A new shirt,	or, 2. A set of building blocks	( )
1. A printing press,	or, 2. A suit of clothes	( )
1. A necktie,	or, 2. Some marbles	( )
1. A magic lantern,	or, 2. A saxophone	( )
1. A suit of clothes,	or, 2. A toy steam engine	( )
1. A pair of rubber boots,	or, 2. A baseball glove	( )
1. A toy boat,	or, 2. A new hat	( )
1. A model airplane,	or, 2. An electric train	( )
1. A kite,	or, 2. A new pair of shoes	( )
1. A pet rabbit,	or, 2. A sweater	( )
1. A book of adventure stories,	or, 2. A water pistol	( )
1. A brush and comb,	or, 2. A drawing set	( )
1. A croquet set,	or, 2. A toy cannon	( )
1. A pet kitten,	or, 2. An album	( )
1. A wallet,	or, 2. A toy auto	( )
1. A blackboard,	or, 2. A necktie	( )
1. Some handkerchiefs,	or, 2. A school bag	( )
1. A pet canary,	or, 2. A pair of sport socks	( )
1. A toy boat,	or, 2. A traveling bag	( )
1. A toy tractor.	or, 2. A tennis racket	( )
1. A pet dog,	or, 2. A Scout suit	( )
1. A Meccano or Erector Set,	or, 2. A book of sport stories	( )
1. A raincoat,	or, 2. Some goldfish	( )
1. A drum,	or, 2. A box of candy	( )

TEST 5

"THINGS TO SEE"

In each pair choose the thing you would like better to see

Would you rather see:

1. A beautiful sunset,	or, 2. A fairy prince	( )
1. Soldiers marching,	or, 2. An auto accident	( )
1. Men digging ditches,	or, 2. Men building a bridge	( )
1. An auto race,	or, 2. Animals in the zoo	( )
1. A bakery window,	or, 2. A chemist working	( )

1. A man getting arrested,	or, 2. An auto factory	( )
1. The North Pole,	or, 2. A fairy castle	( )
1. An artist painting,	or, 2. A king	( )
1. A movie actress,	or, 2. A giant	( )
1. A lot of Indians,	or, 2. A banquet	( )
1. A parachute jumper,	or, 2. An army camp	( )
1. A circus parade,	or, 2. A trial in court	( )
1. A diving exhibition,	or, 2. A stage coach	( )
1. A giant,	or, 2. Girls playing basketball	( )
1. A fort,	or, 2. A boxing match	( )
1. A blacksmith working,	or, 2. A musical comedy	( )
1. A pretty girl,	or, 2. A castle	( )
1. A magic carpet,	or, 2. A diving girl	( )
1. A track meet,	or, 2. Someone falling on the ice	( )
1. Cowboys on a ranch,	or, 2. A movie studio	( )
1. A parachute jumper,	or, 2. A steamshovel	( )
1. A chemist working,	or, 2. A knight	( )
1. Fire engines,	or, 2. A motorboat race	( )
1. A chemical laboratory,	or, 2. Soldiers marching	( )
1. A riot,	or, 2. A fairy castle	( )
1. Santa Claus,	or, 2. A fancy dress ball	( )

TEST 6

"THINGS TO THINK ABOUT"

In each pair choose the thing you like better to think about

Would you rather think about:

1. Traveling in Europe,	or, 2. Cowboys on a ranch	( )
1. Ghosts,	or, 2. The men at West Point	( )
1. Boy Scouts,	or, 2. Famous athletes	( )
1. Success in life,	or, 2. Things you saw at the movies	( )
1. Magic things,	or, 2. Home	( )
1. Wild Indians,	or, 2. Being a famous man	( )
1. College life,	or, 2. Pirates	( )
1. Radio,	or, 2. The funny paper	( )
1. Hikes in the woods,	or, 2. The days when knights lived	( )
1. Heroes of long ago,	or, 2. Men at Annapolis	( )
1. Pretty girls,	or, 2. Giants	( )
1. Knights and dragons,	or, 2. The girls you have met	( )
1. Famous men,	or, 2. Eating candy and ice cream	( )
1. The Wild West,	or, 2. Criminals and detectives	( )
1. Wild animals,	or, 2. Going traveling	( )

1. Magic things,	or, 2. Being popular	( )
1. Automobiles,	or, 2. Eating candy and ice cream	( )
1. The funny papers,	or, 2. The books you have read	( )
1. Civil engineers,	or, 2. Savages in the jungle	( )
1. Wild Indians,	or, 2. The jokes people tell you	( )
1. Airplanes,	or, 2. Hunting in Africa	( )
1. Success in life,	or, 2. The things you like to eat	( )
1. Giants,	or, 2. The funny things you have seen	( )
1. Getting a job,	or, 2. The days when knights lived	( )
1. Famous athletes,	or, 2. Dogs and other pets	( )
1. The Wild West,	or, 2. Your mother and father	( )
1. Playing baseball and other games,	or, 2. Cowboys on a ranch	( )

the pair he was instructed to place the figure *1* in the parentheses at the right. If he preferred the second item in the pair he was to write the figure *2*.

It was feared at first that this simplified scoring system might result in a lowered reliability. To determine this point Test 2 of the preliminary scale in the old form was given to 94 boys in one grammar school. These same boys were also given the same items rearranged in accordance with the new method of paired comparisons. Precautions were taken to equalize the effect of priority of presentation. The reliabilities of the two methods were then computed by the method of split halves and it was found that the method of paired comparisons yielded a reliability of .73 whereas the old method of weighted items yielded a reliability of only .64. The new method therefore was not only much simpler than the old but actually yielded better reliabilities. It is suggested that this method of paired comparisons may have a general usefulness in the field of personality and behavior tests.

The next step was the selection of items. It was decided that each pair should consist of an item which showed increasing popularity with age and an item which showed decreasing popularity. Moreover the two items should increase and decrease in such a way that the graphs representing this increase or decrease should cross each other at about the middle of the age range. To select good pairs of items it therefore became necessary to know how children's preferences in regard to a large number of items increased or decreased with age.

For this purpose many data were available from the work on the preliminary test. Further material was gathered by presenting a large number of items to the boys in one grammar school asking them to express their preferences. The results of all these experiments were graphed and paired items were selected on this basis. It is to be noted that a certain amount of arbitrariness was legitimate at this point because the selection of items was to be tested out subsequently. The worst effect, therefore, of a poor selection of items would be that these items would later have to be dropped.

Finally 224 pairs of items were selected. The scale in this form was given in May 1930 to 982 grammar- and high-school boys from age 8 to age 18. Of these, 584 were from Cleveland, 277 from Detroit, and 121 from Washington, D.C. The responses to each pair of items were tabulated separately for each age. Thus it was possible to see whether the responses to each pair showed a marked tendency to change with age. Pairs which received about the same sort of response throughout the whole age range were, of course, discarded as not being diagnostic. Answers which increased in frequency with increasing age were scored *plus* and those which decreased with increasing age were scored *minus* so that a higher score would characterize the older age-groups. Out of the 224 items in the original test only 28 pairs were discarded as being unsatisfactory, leaving 196 pairs in the final test.

After discarding the 28 pairs just mentioned a scoring key was constructed and the papers were scored. Since there were 196 pairs of items, the highest possible score would be 196. In the course of the scoring 29 papers had to be discarded because they were incomplete. The results of the scoring of the remaining 953 papers are shown graphically in figure 1 while the mean scores by ages are given in

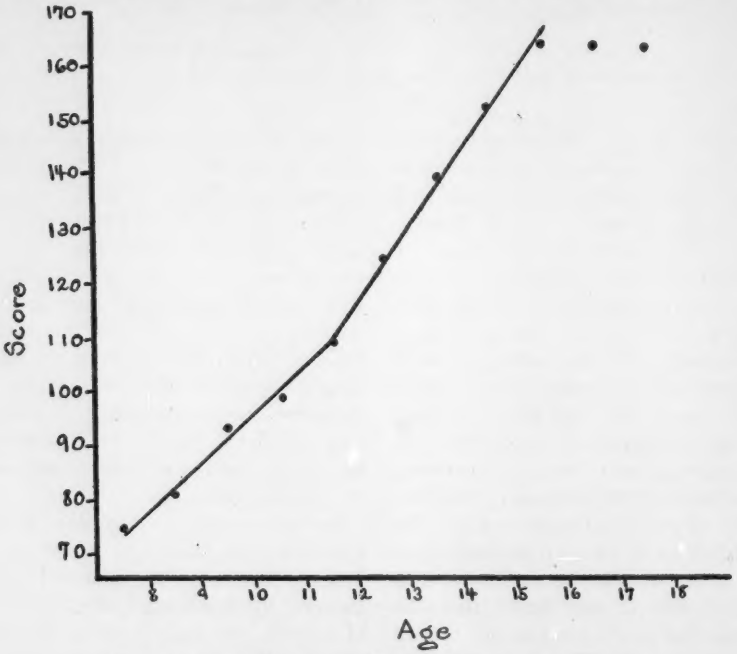

FIG. 1. RELATION BETWEEN SCORE AND CHRONOLOGICAL AGE

table 1. In this table and the other tables in this article "age 8" refers to boys who have passed their eighth birthday but who have not yet reached their ninth birthday.

It will be noted that scores increase quite regularly from age 8 to age 12, then more sharply from age 12 to age 16. After 16 there is no tendency to increase. It is a tempting theory that the acceleration in developmental age after 12 is due to the dawn of adolescence. The phenomenon may, however, be due to factors of selection since the boys in the older age-groups were largely high-school boys who may not be typical of the entire boy population. It is interesting also to notice that developmental age does not increase with chronological age after 16. In this, it resembles Binet mental age. Here again, however, factors of selection may be at work. It is possible that the more mature boys had left high school after reaching their eighteenth birthday.

TABLE 1

Mean scores by ages

AGE	N	MEAN SCORE
8	30	73.33
9	91	80.74
10	99	92.09
11	124	98.30
12	127	108.40
13	99	122.90
14	114	138.20
15	105	152.26
16	79	164.27
17	55	163.04
18	30	162.66
Total.....	953	

RELIABILITY AND VALIDITY

The reliability of the test was computed on the basis of the entire group of 953 individuals. Since reliabilities are spuriously raised when they are computed over a considerable age range it was decided to compute coefficients separately for each age group. The elimination of the effect of chronological age in this manner is a very severe test of the reliability of the scale and one which is often neglected. The resulting reliabilities are given in table 2. It will be noted that they do not fall below .85 at any age and that the mean reliability of the single age-groups is equal to .91. The size of these correlations was one of the happiest surprises of the present investigation.

TABLE 2

Reliability of the revised scale in separate age groups

AGE	N	RELIABILITY
8	30	.85
9	91	.87
10	99	.89
11	124	.90
12	127	.92
13	99	.94
14	114	.93
15	105	.94
16	79	.94
17	55	.96
18	30	.92
Mean.....		.91

It is less easy to estimate the validity of the test because there is no ready criterion of developmental age. In the preliminary scale validity was estimated by correlating test results with ratings obtained from a rating

scale. In the present instance, however, it was felt that this procedure would not be entirely satisfactory because the validity of even the best rating scales is very much subject to question. It is doubtful whether it would be possible to construct a criterion which would be more valid than this test itself. Chronological age would be a very rough criterion. It yielded a coefficient of .82 when correlated with test results over the entire range from age 8 to age 18. This means little more than that there is considerable spread in developmental age in each age-group. The best available answer to the question of the validity of the present scale (and it is admittedly an unsatisfactory answer) is given by the fact that the present test is evidently based on preferences concerned with types of play, books, fantasies, ambitions, and the like. But preferences of this sort are precisely what we mean by the term "developmental age."

RELATION OF DEVELOPMENTAL AGE TO OTHER FACTORS

It seems probable that the scores of the present test are not greatly affected by differences of intelligence. In the work on the preliminary test a partial correlation of .23 (age constant) was found between developmental age and the results of a group intelligence test (Haggerty Delta-2). A correlation of −.15 was found between developmental age as measured by the rating scale previously mentioned and the same test results. The mean of these two coefficients is .04 (4, p. 20). Lawlor (8) working with a group of mental defectives in whom differences of mental age were striking reported correlations of .35 between developmental age and Stanford-Binet, −.04 between developmental age and Porteus Maze, .13 between developmental age and Healy 2, and .70 between developmental age and the Goodenough Drawing Test. Since, however, Lawlor's group showed a large age range (9 to 25 years) and since the correlation of developmental age and chronological age in this group amounted to .45, it is probably true that partial coefficients of correlation (age constant) would have shown little relation between developmental age and the mental tests mentioned.

In the case of the present revised scale, unfortunately, mental test data were lacking for most of the subjects. For a group of 35 boys at age 14 a coefficient of −.12 was obtained. This was the only age group in which enough mental test data were present to secure a significant correlation. For 66 boys between age 12 and age 16 a partial correlation (age constant) of −.08 was obtained. By "mental age" in this paragraph score on the Cleveland Classification Test is meant. The conclusion to be drawn from these data is that there is no demonstrable relationship between developmental age and intelligence.

In the work on the preliminary scale (4) partial coefficients (age constant) of .22 and .16 were obtained between developmental age and weight and height respectively. Miss Zalduondo (9) obtained a correlation of .206 between height and developmental age on the preliminary scale for a group of 43 boys in grades 7 and 8, and a correlation of .362 for developmental age

and weight. These same measurements, however, yielded zero or negative coefficients in grades 4 and 5. A considerable number of other physical measurements employed by Miss Zalduondo showed no clear and definite relationships with developmental age.

In the present study with the revised scale it was possible to investigate the question more thoroughly. The accompanying table 3 gives the results. Average coefficients of .09 and .10 were obtained for the correlation with height and weight respectively. A closer analysis of this table will show the reader that this degree of relationship is due principally to the correlations obtained after age 12. In the lower ages there is practically no correlation between developmental age and physical measurements. The explanation probably is that after this age adolescence enters as a factor. The adolescent boys in each age group tend to be taller and heavier than the rest of the population and also to have a higher developmental age. The whole question of the relationship between physical traits and developmental age calls for further investigation.

TABLE 3

Correlation of developmental age with height and weight in separate age groups

AGE	N	CORRELATION WITH HEIGHT	CORRELATION WITH WEIGHT
8	29	−.07	−.03
9	60	.00	.02
10	53	.03	.10
11	62	.05	.15
12	87	.12	.05
13	57	.16	.14
14	56	.27	.35
15	26	.20	−.02
Mean.....		.09	.10

In order to make practical use of the test it was necessary to calculate developmental age equivalents for each score. This was done by fitting a line graphically to the data as shown in figure 1 and then interpolating. Extrapolation was also used for about one year below and one year above the actual range covered. The results are given in table 4. These figures are presented with considerable hesitation and the reader should so accept them. Attention is called also to the fact that an artificial meaning is given to the term "developmental age" by extrapolating above age 16½. This is precisely parallel to the use of Binet mental ages over age 16. According to the theory on which the Stanford-Binet is based there is no growth in mental age in the average individual beyond the sixteenth birthday. A mental age of 17 on the Stanford-

TABLE 4

Developmental age equivalents of specified scores

SCORE	D.A.		SCORE	D.A.	
	yrs.	*mos.*		*yrs.*	*mos.*
65	7	8	125	13	8
70	8	3	130	14	0
75	8	9	135	14	4
80	9	4	140	14	8
85	9	11	145	15	1
90	10	5	150	15	5
95	11	0	155	15	9
100	11	7	160	16	1
105	12	1	165	16	5
110	12	7	170	16	9
115	13	0	175	17	2
120	13	4	180	17	6

Binet, therefore, does not refer to the mental level of the average 17-year-old. It is an arbitrary designation for a level of mental ability which is 12 "mental months" above the 16-year level. Developmental ages over $16\frac{1}{2}$ are to be understood in the same arbitrary sense.

CONCLUSIONS

1. The present test is a revision of a previously published test for developmental age. The previous test suffered from two particularly troublesome defects. Its scoring system was cumbersome and its reliability was low.

2. The first defect was overcome by the "method of paired comparisons" which not only made the test very much easier to score but actually yielded a considerable increase in reliability.

3. The second defect was overcome by the lengthening of the test and by a more careful selection of items. Reliabilities on single age groups ranged from .85 at age 8 to .96 at age 17 with a mean reliability of .91.

4. Evidence is presented to show that developmental age has little if any relation with mental age. It apparently has a slight positive relation with physical measurements but only after age twelve.

5. Developmental age equivalents are presented for the interpretation of test scores. These are based on the results of 953 tests administered in three cities.

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Strength of Child's Grasp in Complicated Responses

BUFORD JOHNSON AND MAY WILSON

THE following is a report of a further study of the individual differences in children under five years of age in the pressure exerted in grasping during performances requiring coördinated hand movements. A previous investigation (1) showed wide differences among adults and children in the tension of the fingers during tapping movements. Simple and complicated forms of tapping were used. Efficiency of performance appeared to be related to the tension, within limitations of the length of time the tapping was continued. The children were required to tap 30 seconds and the adults 1 minute.

The present investigation was made to study the pressure variations of children with prolonged periods of tapping. Analysis has been made of the changes in the pressure from a simple tapping movement to a more complicated form for one minute periods, and for the complicated tapping prolonged to two minutes.

The apparatus used was the same as that described in the previous article (1). It consisted of the Dunlap Tapping Board and a stylus permitting pneumatic registration of the pressure exerted in grasping the stylus. The reactors were seated during the performance. Records were taken of five types of tapping, each type being performed on a different day, according to the following schedule: (1) Tapping 1 minute on a single plate, called "simple" tapping. The taps were recorded by magnetic counters. (2) Tapping 1 minute, first on the right plate and then on the left, called "complicated" tapping. The taps were registered on magnetic counters. (3) Simple tapping for 1 minute with the pressure stylus. A kymographic record was made of the taps, of the time in seconds and of the pressure of grasping. (4) Complicated tapping for 1 minute, with kymographic record. (5) Complicated tapping for 2 minutes, called "prolonged" with kymographic record. The right hand was used first, and after an interval sufficient for adjusting the drum the left hand was used in a similar manner. The recording apparatus was screened from view.

A more accurate method of scoring the pressure variations was employed in this investigation than in the first study. The area included between the pressure curve and the base line of zero pressure for the ten second periods was measured in square inches with a planimeter. The length of each ten second period was measured in inches. The average height of the pressure curve during each period was calculated by dividing the area by the length of the interval. The maximum height at-

tained by the pressure curve during each interval was measured and recorded.

Twenty children formed the group that we intended to test. The tests on the children under two and one-half years were not completed as the measurements did not seem comparable. The pressure stylus is not as sensitive to the light grasp, but if the thinner rubber tubing were used the older child had a strong enough grasp to touch the central metal rod. Further work on this problem may give a stylus suitable for the different ages, though it appears now that different sizes of the stylus should be used. In several cases the children were not available for completing the series, and the number for which results are given is eleven.

The analysis of the individual records is made with reference to the type of pressure curve, and to the changes in type for simple, complicated, and prolonged movements. These changes are also related to the efficiency of performance as measured by the total number of taps and the accuracy in the coördination of movements during

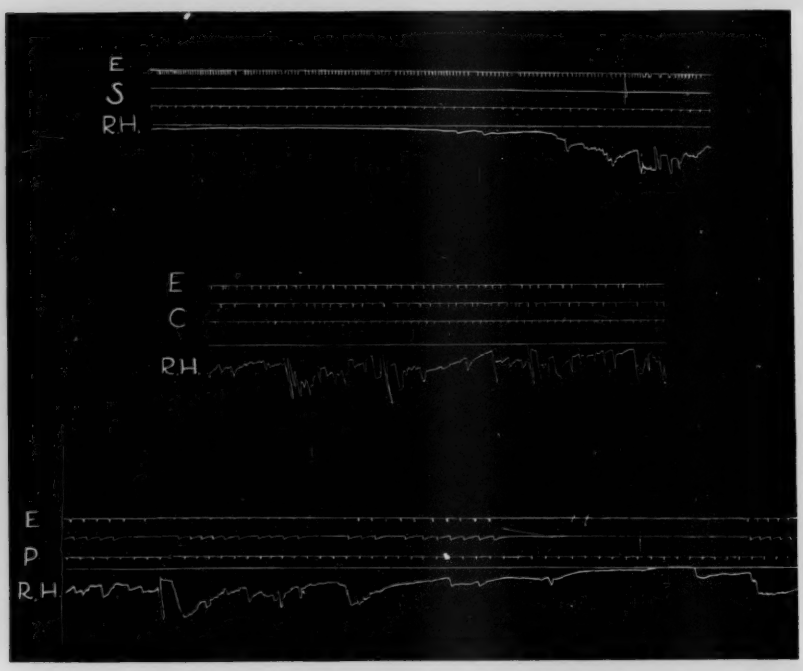

PLATE I. REPRODUCTION OF KYMOGRAPHIC RECORD FOR SUBJECT E SHOWING INCREASED PRESSURE WITH COMPLICATION OF RESPONSE

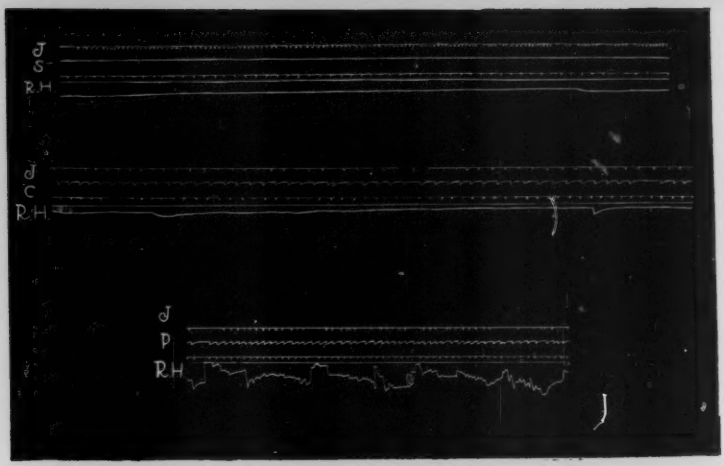

PLATE II. REPRODUCTION OF KYMOGRAPHIC RECORD FOR SUBJECT J SHOWING INCREASE AND VARIABILITY IN PRESSURE FOR PROLONGED TAPPING

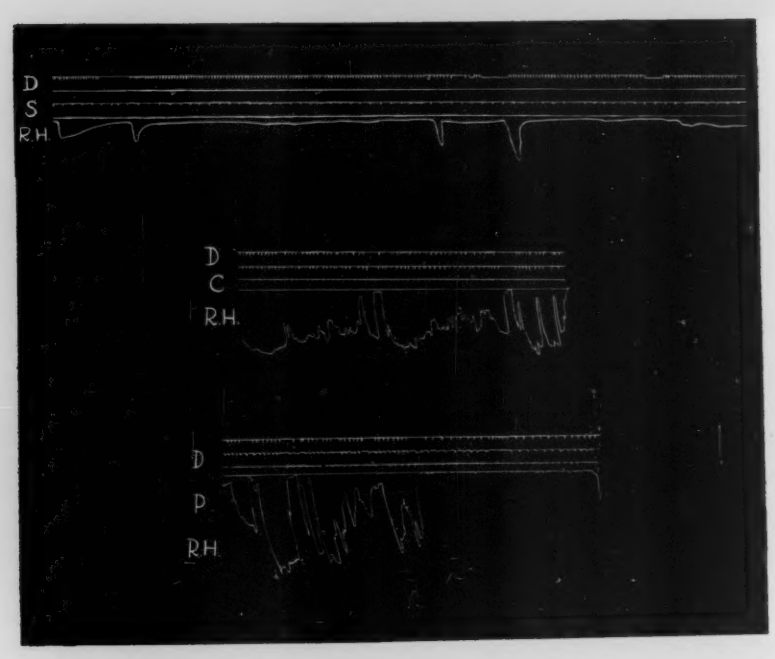

PLATE III. REPRODUCTION OF KYMOGRAPHIC RECORD FOR SUBJECT D SHOWING ERRATIC PRESSURE VARIATIONS AND INCREASE WITH COMPLICATION OF RESPONSE WITH FINAL DECREASE

alternate tapping. Comparisons of the performances were made by means of rank orders under the different conditions.

Typical kymographic records are reproduced in Plates I, II, and III. In all cases these records were made with

The scores in table 1 give the average pressure for each child for 1 minute for each form of tapping.

When we compare the pressure records for the different performances we find 4 children who tend to high pressure for all forms of tapping; 3

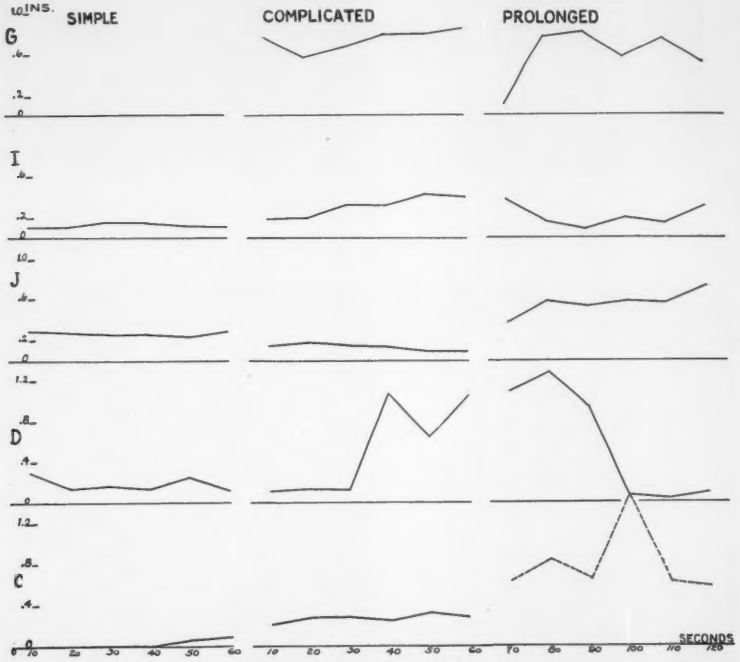

PLATE IV. GRAPHS FOR INDIVIDUAL CHILDREN SHOWING VARIATIONS IN PRESSURE FOR DIFFERENT TYPES OF PERFORMANCE DURING 1 MINUTE PERIODS OF TAPPING

Average height in inches for 10 second intervals are used in plotting the curves

the right hand. The graphs shown in Plates IV and V were drawn from the measurements of the pressure curves. The ordinates of the graphs represent the ten second intervals, and the abscissae represent the average height of the pressure curve for the interval.

children who show slight pressure in simple tapping but increase with the complicated and prolonged tapping. Child C showed the lightest pressure of the group in simple tapping but in rank order for the group changes from sixth place to tenth place in the suc-

ceeding forms. Other children show variations of only a few points in relative standing with regard to pressure. One child used greatest pressure in simple tapping which may be due to an apprehension often manifested by some children when a novel situation is presented.

Group averages of the pressure for the different forms of tapping show an increase from the simple form to the complicated, and a further increase for the prolonged complicated tapping.

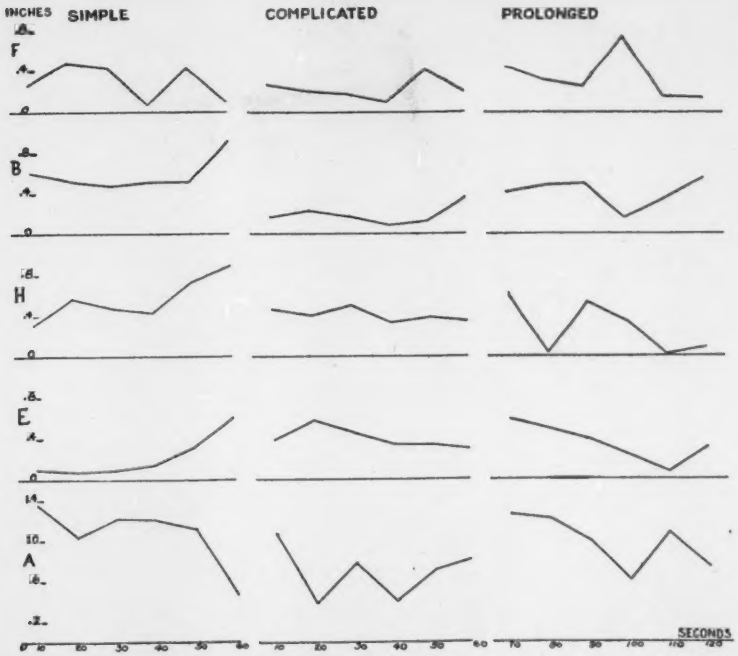

PLATE V. GRAPHS FOR INDIVIDUAL CHILDREN SHOWING VARIATIONS IN PRESSURE FOR DIFFERENT TYPES OF PERFORMANCE DURING 1 MINUTE PERIODS OF TAPPING
Average height in inches for 10 second intervals are used in plotting the curves

Within a tapping period for a given form some children show the increase in pressure toward the end of a one minute period of tapping. Others begin with high pressure and decrease. Some children are erratic or maintain fairly constant pressure. These forms of pressure variations are shown in the plates.

When the changes in rank order are considered, the greatest average change is from the complicated to the prolonged tapping. The averages obscure the extent of the change.

It is difficult to represent with

TABLE 1

Mean pressure scores for ten-second periods of tapping for individual children

	AVERAGE HEIGHT						MAXIMUM HEIGHT						RATIO					
	Right hand			Left hand			Right hand			Left hand			Right hand			Left hand		
	Simple	Compli-cated	Pro-longed	Simple	Compli-cated	Pro-longed	Simple	Compli-cated	Pro-longed	Simple	Compli-cated	Pro-longed	Simple	Compli-cated	Pro-longed	Simple	Compli-cated	Pro-longed
A	1.067	.697	.978	1.406	1.328	.625	1.293	1.428	2.143	2.128	2.472	1.620	1.324	2.148	2.302	1.848	1.894	3.187
B	.593	.202	.398	.105	.216	.22	.835	.38	.898	.270	.400	1.055	1.481	2.058	2.505	1.878	1.811	4.67
C	.025	.268	.8	.184	.432	.548	.032	.403	.153	.248	.498	1.553	1.25	1.51	2.026	1.269	1.216	6.605
D	.185	.88	.577	.593	1.085	.582	.35	1.427	1.605	.902	2.618	1.32	2.633	3.056	9.236	1.571	2.535	2.737
E	.217	.393	.342	.305	.412	.323	.532	.795	.612	.583	.610	.442	3.858	2.08	2.048	1.962	1.486	1.347
F	.277	.245	.338	.476	.873	.251	.875	.428	.735	.850	1.290	.47	2.631	1.566	3.156	1.646	1.376	1.881
G	.000	.753	.785	.126	.247	.435	.000	.978	1.253	.180	.342	1.01	.000	1.3	1.66	1.565	1.38	2.42
H	.558	.412	.272	.546	.479	.745	.810	.863	1.33	1.210	1.060	1.75	1.458	2.136	3.238	2.283	2.177	2.431
I	.115	.313	.208	.198	.154	.195	.425	.838	.652	.268	.223	.262	3.263	2.578	3.238	1.365	1.383	1.419
J	.267	.133	.372	.208	.154	.386	.278	.177	.643	.242	.223	.925	1.045	1.369	1.758	.811	1.57	3.147
K	.517	.620	.215	.645	.368	.308	.935	1.032	.333	1.215	.682	.592	1.863	1.944	2.063	1.929	2.136	1.998

numbers the characteristics of a curve. For example, a pressure curve for a ten second period of tapping may include one or more than one high pressure points. In giving the pressure for such a ten second period a numerical value of the average height of the curve does not furnish an adequate picture, nor does the maximum height. The ratio of the maximum height to the average height seems to have value in representing such raggedness and irregularity of a curve. This ratio has an additional value in being independent of the magnitude of the pressure measurements. That is, it has the same significance in the case of a high pressure curve as in the case of one of low pressure. We have calculated these ratios for the various ten second periods and have found that they indicate a type of behavior which has been observed in tapping as well as in other performances in both children and adults, that is, a tendency to over compensate when the work becomes less efficient. In tapping this compensation usually results, not in the subject's actually tapping faster, but in his tapping with more force. In this laboratory children have worn down a hard metal stylus by this pounding, necessitating its being replaced.

In general, it has been noted that the pressure curves of the prolonged tapping become more ragged toward the end of the two minute tapping period. This results from the effort of the subject to maintain a high rate of tapping, in spite of the fact that muscular fatigue or other factors tend to slow it down. This increase in raggedness of the pressure curve is shown in table 2 by an increase in the ratio from the first ten second interval to the last ten second interval.

Similar data for the left hand show 7 cases in which there is a positive change, and 4 cases in which there is a negative change. The average positive change is 1.72 right hand and 1.173 left hand while the average negative change is 0.37 right hand and 0.169 left hand.

If instead of comparing the first and twelfth ten second intervals, the average value of the ratio for all reactors for the entire one minute period of the complicated tapping is compared to the similar average for the second minute of the prolonged tapping, the average of the ratio for the second minute is found to be greater than the average of the ratio for the first minute of tapping.

TABLE 2

Comparison of ratio measure of pressure for initial and final periods of tapping

Ratio score represents quotient of maximal height for a ten second period divided by the average height for that period.

SUBJECT	RATIO FOR 1ST TEN SECONDS	RATIO FOR FINAL TEN SECONDS	CHANGE
A	1.78	2.07	0.29
B	1.53	1.90	0.37
C	1.24	1.89	0.69
D	1.24	9.33	8.09
E	1.36	1.69	0.33
F	1.23	4.61	3.38
G	1.38	1.45	0.07
H	1.43	2.86	1.43
I	1.17	3.42	2.25
J	1.22	1.58	0.36
K	1.54	1.17	−0.37

Average ratio, first minute, complicated, right hand..... 1.975
Average ratio, second minute, prolonged, right hand..... 3.086

Average ratio, first minute, complicated, left hand..... 1.724
Average ratio, second minute, prolonged, left hand..... 2.890

With each hand there are only two individuals who changed in the reverse direction.

EFFICIENCY OF PERFORMANCE

There are wide differences in the number of taps made by individual children. Age differences for this test have been found in the many studies of tapping though greater overlapping of age groups appears as the age increases. In table 3 the number of taps made by each child in each form of tapping is given. The accuracy of performance is measured by the difference in the number of taps made on the right and left plates in the alternate tapping as given in table 4. The child having the smallest difference ranks first. When the rank orders in the number of taps for the two preliminary forms of tapping recorded by the magnetic counters are compared with rank orders recorded on the kymograph the following changes in rank occur: For simple tapping recorded on counter with simple tapping recorded on kymograph the arithmetic mean of the

TABLE 3

Tapping scores for one minute periods under different conditions

REACTOR	RIGHT HAND			LEFT HAND		
	Simple	Complicated	Prolonged	Simple	Complicated	Prolonged
A	205	116	93	155	120	79
B	168	114	92	155	94	80
C	168	135	132	204	136	130
D	166	138	123	169	122	105
E	153	89	55	123	69	82
F	149	102	94	136	97	96
G	144	137	116	154	115	116
H	142	101	80	149	110	89
I	131	89	79	135	75	52
J	131	98	82	114	74	69
K	100	99	71	135	83	82

TABLE 4

Tapping scores for each plate showing accuracy in coördination of movements

REACTOR	COMPLICATED—1 MINUTE								COMPLICATED—SCORE FOR LAST MINUTE WITH 2 MINUTES OF TAPPING							
	Right hand				Left hand				Right hand				Left hand			
	a	b	Difference	Total	a	b	Difference	Total	a	b	Difference	Total	a	b	Difference	Total
A	56	60	4	116	64	56	8	120	44	49	5	93	41	38	3	79
B	58	56	2	114	47	47	0	94	53	39	14	92	40	40	0	80
C	70	65	5	135	71	65	6	136	65	67	2	132	68	62	6	130
D	65	73	8	138	62	60	2	122	65	58	7	123	51	54	3	105
E	47	42	5	89	35	34	1	69	24	31	7	55	44	38	6	82
F	48	54	6	102	47	50	3	97	46	48	2	94	50	46	4	96
G	72	65	7	137	61	54	7	115	62	54	8	116	62	54	8	116
H	50	51	1	101	60	50	10	110	41	39	2	80	44	45	1	89
I	46	43	3	89	41	34	7	75	42	37	5	79	21	27	6	48
J	49	49	0	98	39	35	4	74	38	44	6	82	34	35	1	69
K	45	54	9	99	35	48	13	83	28	43	15	71	44	38	6	82

amount of change is right hand 2.5; left hand 2.2. For complicated tapping recorded on counters with complicated tapping recorded on kymograph the arithmetic mean of the amount of change is right hand 2.1; left hand 1.5.

The efficiency of performance as measured by the total number of taps decreases with the complication of movements and with prolongation of tapping period. The average number of taps for the group for the last minute of the two minute period was 92.4; for one minute of this complicated form the average was 110.8 taps, showing a difference of 18.4. In every case there was a decrease, but there were wide individual differences in the amount of decrease. The range of scores for the children in the one minute period was from 99 to 138, for prolonged tapping the range was from 71 to 132. In simple tapping the group average was 150.4 taps which is 39.8 more than in the complicated form.

When the efficiency is compared with the pressure scores greater changes in rank order occur than for other comparisons, the average change increasing as the task is prolonged or more complicated. Significant individual differences appear. The child who maintained highest pressure was the most efficient in total output and ranked fairly high in accuracy, which is measured by the difference in taps on the two plates. Another child with high pressure was efficient in total taps but only fair in accuracy. A child with low pressure scores was poor in tapping score. The efficiency appears to be more closely related to the type of curve within a given period of tapping than to the total pressure score.

Analysis of the behavior of these children in social relations shows that the children with high pressure records had difficulties in adaptation. Some who ranked low in efficiency but showed less than average pressure lack initiative ability in activities. They appear slow in action and deliberative rather than spontaneous. The scores in other tests of coördination of movement appear to bear out these conclusions. The Intelligence Quotient does not appear to have a direct relation to the tapping score.

SUMMARY

Those children who show initial high pressure relative to their average pressure and decrease the pressure during the performance appear to be more efficient. In some cases these children have a high total pressure but still maintain efficiency. Others show a lower pressure level in total but the curve of decrease is similar and efficiency is high. Children who show slight initial pressure but increase toward the end of the period may be efficient in the simple task for a brief period but when it is prolonged and the task is complicated their efficiency is greatly reduced. The child who shows erratic changes in pressure is rarely high in efficiency and often becomes inaccurate and falls into a low rank.

Previous study of a few adults showed that the person who maintained light pressure throughout was the most efficient but the reactor with high pressure in initial seconds with gradual decrease was almost as efficient. It may be that in such simple

performances as the tapping test, the adult has attained an efficiency in movement through reduction of tension in fingers. A survey of past and current individual records tends to favor the second form of pressure as an indicator of efficiency.

It is probable that the pressure records could be wisely used in directing the young child's activities toward relaxation for some and alertness for others. The results of this investigation lead us to conclude that habits of reaction based upon temperamental tendencies may be studied to advantage by this method.

REFERENCE

(1) JOHNSON, BUFORD: Changes in muscular tension in coördinated hand movements. Jour. Exper. Psychol., 1928, 11, 329–341.

The Effect of Bodily Orientation upon the Young Child's Memory for Position of Objects*

L. Lucile Emerson

Historical Summary

For some years spatial perception has been a topic of philosophical and psychological treatises. The bulk of the literature bearing upon this psychic factor deals with the theoretical nature of the problem, discussing the origin and growth of spatial perception. The fact that visual perception and spatial relationships are well organized in the adult is a very common observation. The determinations of the beginnings of such organization is a problem which can best be solved by the study of children. Very little work has been done on this topic. It is hoped that future investigations will be concerned with development of spatial perception and relationships in the young child as the past has been concerned with the adult status of these factors.

Various psychological theories of spatial perceptions have been advanced by eminent psychologists. The genetic theory supported by W. Wundt lies at one extreme, while the nativistic theory upheld by Herring and M. Von Frey presents the opposite point of view. The genetic idea is that perception of space is derived from the final fusion of sensations which in themselves are spaceless. This idea as expressed by Wundt is that "all spatial ideas are arrangements either of tactual or visual sensations." Opposed to this theory is that of the nativist who argues that all sensations have fundamental spatial characteristics. Wundt, in commenting upon the child's perception of space, expresses the belief that such perception is much less complete in the child than in many animals.

Titchener (13) advances a theory which he himself says is half-way between these two extreme theories. According to his reasoning, some sensations have a characteristic of spatial extent which make "localization of these sensations a necessary consequence of qualitative differences within total bi-dimensional fields." Furthermore, the visual perception of a place or position is highly organized in the individual; stimuli which have spatial differences are definitely placed in spatial relationships to one another.

P. Swindle (12) in reviewing Kaila says that the latter believes there is little foundation for a classification of individual's space perception into three

* From the Institute of Child Welfare, The University of Minnesota. To Dr. Florence L. Goodenough who directed this problem and to Dr. John E. Anderson who offered many helpful suggestions I make acknowledgment of my indebtedness.

dimensions, but that "each response has its own spatial attribute and its manifestation means perception of space in a particular form or dimension."

Pillysbury (10) in commenting upon perception maintains that perception as a whole is a much simpler problem than that of association. He believes that it is difficult for anyone to determine when perception and association are not united; for him the problem of perception is largely one of association. One of the best as well as one of the simplest definitions of perception given in psychological texts is that given by Woodworth (18) when he says that "perception is knowing the fact." Facts that are stimulating the eye are known as visual perceptions. These visual perceptions offer the data for the perception of spatial facts.

Perhaps the most comprehensive viewpoint of the conception of spatial relationships in the young child has been elaborated by Stern (11) and Koffka (7). These two men have endeavored to show how space perception has developed in the young child. Stern (11) says that even by first year there is a beginning of the conception of space. He uses the term the "conquest or mastery of space" to explain the growth of spatial perception in both ideas and actions. Here we have the mental and physical grasp of space going on simultaneously. Stern believes that psychology has long been laboring under the mis-conception that the mental and physical conception of space is entirely separated. This was perhaps due to the fact that most of the investigations that have been carried on were done with adult subjects. Stern's interest is also centered in the question as to whether spatial perception is native or acquired. This also he believes can be answered only by a study of child psychology. In this regard he says there is no act of perception of a familiarity with space in which both natural and acquired faculties do not take part. Koffka (7) also is interested in the child's conception of spatial relations. To the infant the objects which arouse reactions are those within his field of vision. In the young child this field of vision is confined to a very narrow range of space. He sees first only those things which are directly in front of him.

Actual experimentation that has been done in this field of spatial relationships is limited. Miss Williams (16) states that P. Meyer in 1919, carried out an experiment on memory for spatial position for oddly shaped figures or objects. Objects were presented in different positions of rotation toward the right, left, backward and forward. After a delay of twenty-four hours the observer was required to identify the position in which a given figure was originally presented. The results of this experiment yielded the following conclusions: (1) that there were various tendencies toward error, (2) that the errors were especially noticed in the identification of neighboring and symmetrical positions with the original, (3) that there was inability to determine degree of rotation though the direction was correctly given.

S. R. Court (3) studied the development of number time and space concepts in a child from twenty months to five years of age. At two years of

age a spontaneous interest in numbers was observed. At the age of three years 5 months the boy could count to twelve; and at 4 years 3 months he could count to 100. Conception of time was first manifested at 20 months in the child's preference for simple stories in which the verbs were all in the same tense. He understood the future tense at 2 years, knew the seasons at 4 years, and could tell time at 4 years 10 months. His first inclination to measure space was at 2 years 10 months when he measured one object in relation to another. At 3 years he could appreciate space and distinguish between objects of different size. The subject's sense of orientation was good at 2 years at which time he knew his way home from four directions each two or three blocks distant. At 3 years he knew the location of three inter-urban stations and the relation of each to his home. Interest in "near" and "far" was apparent by 4 years. In conclusion, Court states that interest in space in some of its phases was less spontaneous than interest in time and number. Space measurement was influenced by external conditions many times. She concludes that, "growth of this child's appreciation of space and of his sense of orientation is as natural as is the growth of his body."

Aside from those experiments dealing with static equilibrium, comparatively very little work has been done in respect to the ability of an individual to maintain his sense of position or bodily orientation. The ability of the individual to maintain his normal bodily position and spatial relationships in reference to the surroundings is spoken of in psychology as "orientation." This is a factor so closely tied up with space perception that it also merits a closer treatment.

The best psychological definition of bodily orientation is probably that one given by J. M. Baldwin (1) in his dictionary of psychological terms when he defines bodily orientation as "the undisturbed consciousness of the spatial relationships of the body as a whole to its surroundings." He affirms that the orientation of a body to its surroundings is conditioned by many factors such as factors of sense, number, visual sensations, cutaneous sensations and auditory sensations. Orientation of body becomes reflexive and only comes into consciousness when it is disturbed.

Stern (11) deals with a child's sense of position. Both mathematically and psychologically the individual's conception of space must begin from a definite center. In mathematics this center is any arbitrarily assigned point, but in psychology, space center has only one position and that is "in the person of the perceptive individuality." That is every man is the center of his own space and his dimensions of right or left, up or down, backward or forward, are in relation to his own body. All things then in the external field of space are brought into some relative position with individual space. According to Stern the young child does not completely master his individual space before he masters the concept of outer space. These two conquests of space go hand in hand. The child has a consciousness of the sense of position. The vestibular activities and the semi-circular canals

of the inner ear help in knowledge of sense of position.

Koffka (7) in his discussion of the sense of position says that the infant's field of vision is limited, so that he sees only those objects which are before him and not those which appear at one side, above or below. He says, "to the child form is much more independent of spatial position that it is to adults." To support this contention Koffka cites the ability of children to recognize pictures even though the pictures are turned at angles varying from ninety to one hundred eighty degrees. In adults however, the recognition is dependent upon the absolute orientation of the figure. To the adult, "right, left, above and below become characteristic properties of the different members of configuration and consequently of the total form." As Koffka suggested children's perception of sense of position would be of sufficient significance to justify painstaking investigation.

Baldwin and Stecher (2) in their explanation of the adaptation board used in experimentation with young children state that the ability of an individual to adapt himself to a changed situation is known to correlate highly with intelligence. In tests using the adaptation board, the degree of success attained by the child depends to a great extent upon attention and observation of the experimenter's movements and ability to remember them. The most important factor in the whole test is the ability to visualize a new position of the board in relation to the old. In reference to adaptation of the body to a new position, Janet makes this statement—"the reversal of position in visualizing of situation could account for the certain illusions of orientation."

Trowbridge (14) has formulated two methods of orientation which he calls ego-centric orientation and domi-centric orientation. The ego-centric is that method which is generally used by civilized man. In this there is an intersection of lines at the ego going out to the cardinal points of direction. That is, a man's own body is his center for all space. The domi-centric is a method used by birds, mammals, fish, and even young children whereby orientation is established with reference to some external object which is usually the "home." How ever, the orientation system which man uses is very complex and is probably a combination of both of these two methods. The consciousness of "body sense position" has arisen gradually to the final form found in adults. Yet it should not be considered an innate faculty but one that is furnished by the sum total of various senses.

Trowbridge states that birds because of the phenomena of lateral vision have an advantage over man in the maintaining of bodily orientation. The bird as it moves through unfamiliar space depends on the subconscious summing up of space relations which are immediately about it. He says that the importance of lateral vision to near-by orientation has not heretofore been properly emphasized. Williams (17) in discussing Trowbridge's article says: "Distance is judged by relative displacement. This should be considered in any

theory of orientation implying a sense of direction."

Closely related to these problems of spatial perception and bodily orientation are the experiments which have been carried on with the purpose of studying the delayed reactions of animals and children. Hunter (5) states that the delayed reaction problems can be solved in two ways: "By maintenance of bodily orientation in whole or in part during the interval of delay or by the chance recovery of the proper orientation just at the moment of release; or by some intraorganic factor (non-orientation) non-observable to the experimenter."

If the animal solves the problem by the first method he is responding in agreement to his bodily orientation but if he solves it by the second method it is not in agreement with orientation.

In the experiments which Hunter carried out he kept a detailed record of the direction in which the animal in the problem box was orientated. The release box in which the animals were released was large enough so that the animals were free to take up any position and maintain a certain bodily orientation. He states that in no case where an animal depended upon use of orientation as a cue, did he begin the use of non-orientation factors for cue. Hunter's experiments show the following results in regard to orientation:

Rats in order to make the correct responses must maintain gross bodily orientation. If the bodily orientation is lost, any of the lighted boxes may be entered. Dogs follow the orientation of the head making the correct responses regardless of which box is nearest. Racoons made two types of responses: (a) Several made correct reactions when bodily orientation was the cue for the response; (b) Some other raccoons made correct response in which bodily position did not enter as a cue for the response. In these cases some intra-organic factor (non-orientation) must have been responsible for the reaction. Children made correct response where bodily position was not kept constant during the interval of delay and therefore solved the problem by some other means which Hunter believes were of an ideational nature.

Although spatial perception has been treated in psychological discussions since the beginning of psychology, not very much experimental work has been done in the field. Various theories have been advanced concerning the origin and growth of spatial perception. Child psychology serves as a logical basis for the beginning of the study of this complex function. Little actual experimental work has been done in the field of child study in space perception. From those investigations which have been carried on the conclusions reached are that the young child early begins to form a conception of spatial relationships to the right and left, up and down, or backward and forward.

Bodily orientation or sense of position is a factor which develops gradually. It is influenced by many factors. The adult regards himself as center of his own space and his regard of external objects is always in relation to his own individual space. Even in the very young child there is a consciousness for sense of position. How-

ever, the child regards external objects as a center of space. Delayed Reaction experiments have shown that rats, dogs, and some raccoons use bodily orientation as a cue to the reaction. Some raccoons and all children use some other factor which Hunter has named intra-organic (non-orientation) as a cue for the response.

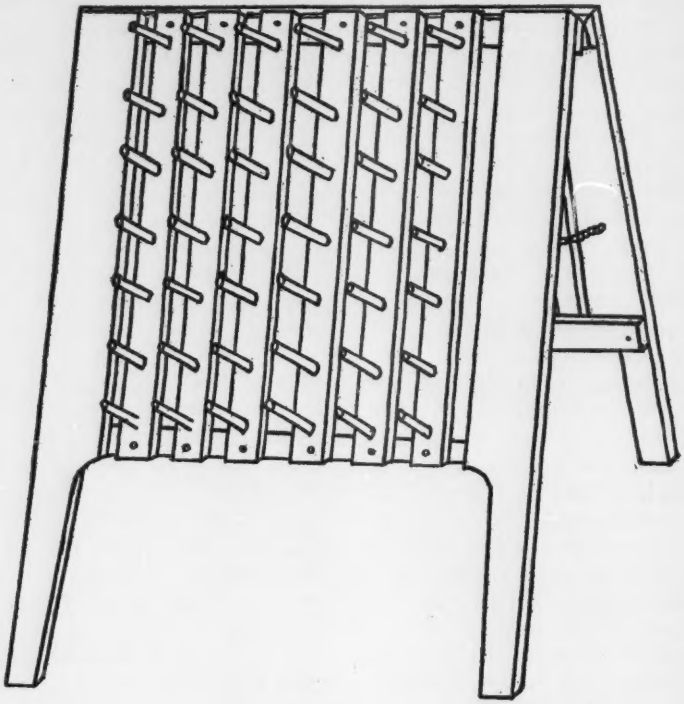

DIAGRAM I

PROBLEM

The purpose of this study was to determine the effect of bodily orientation upon memory for spatial placements of wooden rings on an easel designed for this experiment (Diagram I) and to note any factors which seem to influence ability to make successful placements. The effects of orientation was measured by changing the position of the easel in relation to the child.

METHOD

Positions of easels

After a preliminary experiment with 33 children, 9 positions of the easel were selected to be used in the study. In two of the positions only one easel was used; in all the others two easels

were used, one for the child and one for the experimenter. The 9 positions arranged in the order of their seeming difficulty follow. In figures accompanying list of positions: 1 indicates position of child as examiner places ring; 2 indicates position of child as he places his ring.

1. One easel

$\overline{1,2}$

2. Two easels parallel to each other

$\overline{1}\ \overline{2}$

3. Two easels at right angles requiring one quarter turn to the right

$\left|\begin{matrix}\overline{1} \\ \quad 2\end{matrix}\right.$

4. Two easels at right angles requiring one quarter turn to left

$\left|\begin{matrix}\quad\overline{1} \\ 2\end{matrix}\right.$

5. Two easels at right angles requiring three-quarter turn to left

$2\left|\begin{matrix}\quad \\ \overline{1}\end{matrix}\right.$

6. Two easels at right angles requiring three-quarter turn to right

$\left|\begin{matrix}\quad \\ \overline{1}\end{matrix}\right.2$

7. Two easels one behind and a little to the right of other

$\begin{matrix}\quad\overline{2} \\ \overline{1}\end{matrix}$

8. Two easels facing each other

$\begin{matrix}\overline{1} \\ \overline{2}\end{matrix}$

9. One easel requiring movement to the opposite side of the easel

$\begin{matrix}2 \\ \overline{1}\end{matrix}$

The easel upon which the experimenter placed her ring was kept in a constant position throughout the study, while the easel upon which the child placed his ring was changed to form the various positions. The two exceptions are positions 1 and 9 in which the same easel was used by both the experimenter and the subject.

Placement of rings on easels

Diagram II gives the twenty placements used. They were as follows in order of arrangement on the chart:

o	o	o	o	o	o
1			9		2
o	o	o	o	o	o
11	15		17		13
o	o	o	o	o	o
		19			
o	o	o	o	o	o
7		5	6		8
o	o	o	o	o	o
12			20		14
o	o	o	o	o	o
		18		16	
o	o	o	o	o	o
3		10			4

DIAGRAM II

Four corner placements (1, 2, 3, and 4).
Two center placements (5 and 6).
Four middle placements (7, 8, 9, and 10).
a. Middle of the right side.
b. Middle of the left side.
c. Right center of the top side.
d. Left center of the bottom side.
Two placements on the left side (11 and 12).
a. Two places up from the middle.
b. One place down from the middle.
Two placements on the right side (13 and 14).
a. Two places up from the middle.
b. One place down from the middle.

Two placements diagonally from the corners (15 and 16).

a. Upper left corner down.
b. Lower right corner up.

Four placements off center (17, 18, 19, and 20).

a. Two places up right.
b. Two places down left.
c. One place up left.
d. One place down right.

Subjects

Thirty-two children attending the nursery school of the Institute of Child Welfare at the University of Minnesota served as subjects in this study. Not all children completed all nine positions because of extended absences due to illness or withdrawal from the nursery school. Table 1 gives the number of children who completed the series of positions, and table 2 the number completing each position.

TABLE 1

Number of positions completed

TOTAL NUMBER OF POSITIONS COMPLETED	TOTAL NUMBER OF CHILDREN
9	27
8	1
7	2
4	1
3	1
Total number.....	32

The children ranged in age from two to five years and were divided into three age groups, 12 children from 2 years 3 months to 3 years 5 months composed the three year group; 12 children from 3 years 6 months to 4 years 4 months composed the four year group; 8 children 4 years 6 months to 4 years 11 months made up the five year group.

I.Q.'s for the entire group ranged from 82 to 168.

Sex

The group was divided into 18 girls and 14 boys. The experiment was planned to include an equal number of each sex, but because some children showed negativism they could not be used successfully.

Interval between trials

Children were tested on alternate days as consistently as attendance permitted until the nine positions were completed. All children finished the series within three weeks with the exception of three children who finished within four weeks.

TABLE 2

Number of children completing each position

POSITION	CHILDREN
I	30
II	31
III	32
IV	28
V	29
VI	30
VII	31
VIII	31
IX	30
Total positions.....	272

Time of day

Of the total of 272 trials 233 were given in the morning between 9:00 and 11:15; and 39 trials were given in the afternoon between 2:30 and 3:30.

Elimination of practice effect

(*a*) *Position.* In order to distribute the effect of practice equally upon all

nine positions, each position was given first to three or four children. Positions I, II, VIII and IX were given to 3 children first, and the remaining positions, III, IV, V, VI and VII were given to 4 children first. After the first definite position for each child, the remaining positions were given in chance order.

(*b*) *Placement.* Since there was also a possibility that practice might influence the success of the correct placing of the ring on the easel, the twenty placements were not presented to the child in consecutive order. Twenty different arrangements of the twenty placements were made so that each of the twenty placements occurred in the first, second, third, fourth, fifth, ... twentieth place in the series of twenty arrangements. Because there were more than twenty children used in the study each of the first twelve arrangements were given to two children and the other eight arrangements to only one child. Thus the experimenter had a definite order of presenting the placements to each individual child.

It was thought that the younger children might not coöperate if the placements which were given first were too difficult for them. Since the four corner placements were expected to be least difficult the arrangements which began with these placements were assigned to these children.

Testing room

The study was carried on in whichever research room was available at the time. All rooms are equally familiar to the children; thus the fact that the same room was not used all the time had no significant influence upon the response of the children.

Interval between the experimenter's and child's placement

The time elapsing between the ex perimenter's placing of her ring on the easel and the child's placing of his ring was never less than five seconds.

PROCEDURE

Situation

The easels were always arranged in the proper position for the trial before the child was asked to come into the room. The child was invited to come and play a game with the experimenter. In most cases one of the nursery school teachers told the child that Miss E. had asked him to play with her.

Directions

When the child came into the room for the first time the examiner said to him, "This is my little house (pointing to experimenter's easel). Now I am going to put my ring right here in my house and I want you to put your ring just like mine in your house." If the child did not seem to understand after the first trial the directions were repeated.

After the first time the child was told, "Today this is your house in this place, and I want you to put your ring just as I do in my house." Since the child's attention was inclined to waver after each placement, the examiner said, "Look where I am going to put it this time."

Length of time

The time required for making twenty placements at each trial was approximately five minutes for each child.

Incentives

Since after a few trials the game itself was no longer an incentive, though the children did not object to playing it, three kinds of incentives were used in consecutive order. First, the experimenter drew a simple outline picture of a house on a piece of paper which the child was allowed to keep. In order to keep interest at its height and to avoid any effect of indifference, a drawing of a wooden ring on a similar piece of paper was next used. Before the children became tired of this, the experimenter gave them cut-out paper rings of a different color each day.

RESULTS

The delayed reaction experiments which have been carried on with animals and children have shown that some animals and all children use some factor other than bodily orientation as a cue to the reaction. No one has actually attempted to determine the effect of bodily orientation upon memory for position of objects. The ability to adapt to spatial relationships is present in some degree in young children, as may be judged from their early ability to adjust themselves to space. Whether this ability in young children is affected by change in bodily position, or whether it is a constant ability may be solved only by empirical methods of study. There may be age differences in the effect which a change in bodily position has upon memory; that is, older children because of their greater experience or because of their actual age may be more or less affected through the setting of habits of reaction than younger children.

Effect of Change in Position

By tabulating the number of correct placements for each of the nine bodily positions, the order of difficulty of these positions was determined.

TABLE 3

Relative difficulty of nine orientation positions

POSITION	TOTAL NUMBER CORRECT	MEAN	S.D.	ORDER OF DIFFICULTY
I	534	17.82	2.65	1
II	200	6.45	3.501	3
III	165	5.55	2.823	4
IV	135	4.96	2.501	5
V	154	5.43	3.162	6
VI	147	4.64	2.440	7
VII	211	6.86	3.333	2
VIII	92	3.71	1.412	8
IX	48	1.81	1.201	9

Position I, in which the child placed the ring upon the experimenter's easel after she had removed her ring, was found to have the largest number of correct placements. From this it may be judged to be the easiest position, since there were three times as many correct placements as in the position having the next highest number of correct placements. Positions II and VII which are the two parallel positions, were of approximately equal difficulty as judged by average number of correct placements. Positions III, IV, V and VI, the four right angle positions were also of approximately

equal difficulty, as evident from the similarity of average number of correct placements. Position VIII, in which the child's easel faces the examiner's, was slightly more difficult than the positions involving only a partial turn to the right or left. Position IX, which required the child to place his ring on the reverse side of the examiner's easel, was the most difficult, the average number of correct placements being less than two. The standard deviations of all the positions show very nearly equal variability of the children in the nine orientation positions.

These data seem to indicate that the more change in bodily position the child makes, the more difficult it is for him to put his ring in the proper place. Thus it may be inferred that bodily orientation has a distinct influence upon memory for placement of rings upon the easels used in this experiment.

In order to determine whether or not the test was of equal difficulty for all children the reliability of the difficulty of the nine orientation positions was found to be +.88, which is significantly high. This was computed by correlating the total number of correct placements for the odd numbered children with those for the even numbered children on the nine orientation positions. There may be factors other than a change in bodily position involved in this ability to remember ring placements. In other words, the influence of bodily position may be in part dependent upon chronological age, mental age, I.Q or sex of the subjects.

Chronological age

The influence of chronological age upon the effect of a change in bodily position is shown in Table 4 in which the subjects are grouped according to three ages, 3 years, 4 years, and 5 years.

There is a general increase in the average number of total correct placements from age group to age group. There is not, however, an equal increase between the 3 and 4 year olds and the 4 and 5 year olds, indicating possibly that the ability to make proper placements develops early and rapidly and does not show a constant increase. This seems to follow the general curve for mental growth which is characterized by negative acceleration. With more cases a conclusion could be made regarding that part of the developmental curve which falls between the ages of 21 and 59 months.

There is no consistent nor equal gain on the nine individual positions among the three age groups. However, there are no losses in total number of correct placements between age group I and II, while there are losses rather than gains for three of the nine positions between age groups II and III. Also, the gains are greater on the average between groups I and II, indicating that the large differences found between the average gains in total number of correct placements between groups I and II and groups II and III are not a matter of one or two positions only, but seem to be distributed quite equally over the nine positions. This suggests that the

function involved is unitary; the nine positions merely representing different levels of difficulty along a given curve. of the child; but there also seems to be an indication that there are other factors which influence this ability.

TABLE 4

Distribution of correct placements according to chronological age

AGE GROUP	NUMBER OF CHILDREN	TOTAL NUMBER CORRECT	MEAN NUMBER CORRECT	RANGE TOTAL NUMBER CORRECT	INCREASE AVERAGE NUMBER CORRECT
I. 3 years (27–31 months).....	12	525	43.75	24–68	
II. 4 years (42–52 months).....	12	672	56.00	39–82	Group I to II, 12.25
III. 5 years (54–59 months).....	8	474	59.24	54–98	Group II to III, 3.24

TABLE 5

Distribution of correct placements according to position and chronological age

POSITION	I 3 YEARS		II 4 YEARS		III 5 YEARS		AVERAGE GAIN IN NUMBER CORRECT	
	Mean number correct	S.D.	Mean number correct	S.D.	Mean number correct	S.D.	Group I to II	Group II to III
I	15.66	2.61	17.16	2.08	17.37	2.08	+1.50	+.21
II	5.00	2.08	7.83	3.13	7.87	3.14	+2.83	+.04
III	3.00	3.12	5.33	2.09	6.87	2.28	+2.33	+1.54
IV	3.00	2.09	5.16	3.12	4.75	2.94	+2.16	−.41
V	3.91	2.07	4.66	1.84	6.38	2.19	+0.75	+1.72
VI	3.66	1.88	5.66	2.80	4.63	2.96	+2.00	−1.03
VII	5.08	3.16	6.50	2.43	7.38	3.04	+1.42	+.88
VIII	3.00	1.67	3.08	1.33	2.87	1.80	+0.08	−0.21
IX	1.41	1.20	1.50	1.42	1.75	1.06	+0.90	+0.25

The correlation between chronological age and the total number of correct placements for the nine orientation positions is .77 ± .05 as computed by the Spearman rank order method. There is, evidently, some relationship between the ability to make proper placements and the chronological age

Mental age

The correlation between mental age and number of correct placements is .758 ± .05. This indicates approximately a relationship equal to that found between chronological age and number of correct placements.

Specific ability

Since chronological age, mental age, and I. Q. seem not to be wholly responsible for the ability to make correct placements, there is indication of specific ability to remember the relationship of the ring to the easel. By correlating the total number of correct placements on all positions for the even numbered placements with the total number of correct placements on all positions for the odd numbered placements, the reliability of the problem as a measure of the particular ability involved for the various children is found to be .96. This seems to indicate, as suggested above, that there is a special ability in the young children used in this study, since the discrepancy between the reliability of the test as a measure of the orientation ability of the children and the correlation with either chronological age or mental age is greater than would be expected by chance.

Sex

Whether there is a significant difference between boys and girls in this study is shown by the average number of correct placements for each sex.

	Boys	*Girls*
Mean number correct	50.00	52.40
S.D.	10.53	14.66

No significant sex difference is found, except that girls seem to be more variable than boys. This difference too is within the limits of chance.

TABLE 6

Classification of errors

POSITION	SYMMETRICAL ERRORS				ERRORS IN ROW		ERRORS IN COLUMN		RANDOM ERRORS	TOTAL ERRORS
	Right	Left	Up	Down	Up	Down	Right	Left		
I	9	5			8	9	78	15	6	116
II	62	77			28	27	98	165	110	428
III	72	70			25	24	126	130	129	434
IV	99	73			20	23	145	124	110	422
V	86	57			28	39	152	94	116	429
VI	59	81			28	22	89	144	166	449
VII	47	85			20	42	69	132	126	389
VIII	113	114			24	16	172	131	142	485
IX	113	119			15	20	194	168	154	551
Total...	666	681			199	222	1,023	1,103	1,059	3,703
Mean...	74.0	75.6			22.1	24.6	113.5	122.5	115.4	411

Classification of Errors

Errors were classified into six groups as follows:

1. Symmetrical Errors—(i.e. reversal of placement, right and left—up and down).

2. Errors in Row—Number of places *up* (column correct).

3. Errors in Row—Number of places *down* (column correct).

4. Errors in Column—Number of places to *right* (row correct).

5. Errors in Column—Number of places to *left* (row correct).

6. Random Errors—Error in both row and column and non symmetrical.

Little difference is observed between the tendency to reverse a right position and the tendency to reverse a left position as is evident by the slight difference in averages, 74.0 and 75.6. It is interesting to note that there were no symmetrical errors up or down, which indicates that the young child distinguishes between up and down more successfully than between right and left. This is also indicated by the difference when the average number of errors in row are compared with the average number of errors in column. An average of 46.8 errors were made up and down, while an average of 236.00 errors to the right or left were made. The average number of errors up almost equals the average number of errors down; the difference is probably due to chance. The difference in the average number of errors to the right or left is also probably due to chance, since the actual difference is only 9 points for 1000 errors, while the actual difference between errors up and down is 2.5 points for two hundred errors. Obviously the relation is practically the same in the two cases.

The reliability of the difficulty of the twenty placements on the easel (sum of all the nine orientation positions) as determined by correlating the number of correct placements for oud numbered children with the number of correct placements for even numbered children, is .936, which indicates that the placements show a reliable difference in difficulty for all the children in this study.

Difficulty of placements

Table 7 presents the number of times each of the twenty placements was made correctly. The twenty placements were divided into four separate categories: 1. The four corner placements (Placements 1, 2, 3, and 4); 2. The six marginal side placements other than the corners (Placements 7, 8, 11, 12, 13 and 14); 3. The two marginal top-bottom placements other than the corners (Placements 9 and 10); 4. The eight inside placements (Placements 5, 6, 15, 16, 17, 18, 19 and 20). Table 8 shows the percentage of correct placements and the standard error for each of the four

TABLE 7

Difficulty of twenty placements

PLACEMENT NUMBER	TOTAL NUMBER CORRECT	PERCENTAGE CORRECT	ORDER OF DIFFICULTY
1	118	43.30	19.5
2	118	43.3	19.5
3	110	40.4	17
4	111	40.7	18
5	64	23.5	6.5
6	54	19.8	3
7	58	21.3	4
8	66	24.2	9
9	94	34.5	13.5
10	101	37.1	16
11	95	34.9	15
12	78	28.6	11.5
13	94	34.5	13.5
14	63	23.1	5
15	64	23.5	6.5
16	53	19.4	2
17	78	28.6	11.5
18	70	25.6	9
19	51	18.7	1
20	65	23.7	8

categories. This table indicates that the four corner placements had the highest percentage of correct placements with a small standard error. The marginal placements were next in difficulty, the top-bottom placements, having a larger standard error, indicate a greater variability. The inside placements were decidedly the most difficult the standard error showing a small variability for the children of the study.

TABLE 8

Percentage of correct placements in four categories

CATEGORIES OF POSITIONS	PERCENTAGE CORRECT	σp
I. Four corner.....	.420	.016
II. Marginal side (Other than corner).....	.378	.013
III. Marginal top-bottom (other than corners).....	.358	.021
IV. Central.....	.210	.009

TABLE 9

Relation between the actual differences and the standard error of the difference in percentages of correct placements in four categories

CATEGORIES	1	2	3
2	2.1		
3	2.37	.76	
4	17.5	9.30	5.29

In order to determine if the difference between the percentages of correct placements was significant the standard error of the difference of the percentage of correct placements of the four categories was calculated and the actual difference in percentage was divided by the standard error of the difference. Table 9 indicates that there is a significant difference between each of the four categories of placements; they were not, therefore, of equal difficulty. The difference between the corner placements and the marginal side placements is twice (2.1) its standard error which indicates a significant difference in difficulty of these two types of placements. Marginal side placements and marginal top-bottom placements were of approximately equal difficulty, the difference of percentage of correct placements being only .76 that of the standard error of the difference. The difference between the corner placements and the inside placements has a highly significant ratio (17.5). There is also a significant difference between marginal side and central placements and between marginal top-bottom and central placements as shown by the ratios 9.30 and 5.29 respectively. Thus it can be said that the four corner placements were the easiest; the marginal-side placements ranked next in difficulty, with the marginal top-bottom placements showing almost equal difficulty, and the inside positions being the most difficult.

The data of this study may be interpreted in the light of some of the theoretical conclusions which have been advanced in regard to spatial relationships and change in bodily position. According to Stern (11) the child of one year can distinguish "far" and "near," "above" and "below," "right" and "left." The data of this study show that all the children used in the study had some grasp of spatial relationships since no child

failed any single placement in all nine positions. Even in the youngest child some ability to grasp spatial relationships was already present. Stern (11) also points out that the child's mastery of space is not perfect in these early years and that there are many misconceptions of spatial relations. Data of the study confirm this by the various types of errors which were made. That this spatial conception develops with age is indicated by the increase in the total number of correct placements for each of the three age groups of the study.

Koffka (7) also asserts that the ability to adjust to spatial relationships is early evident in young children. He believes that adjustment, however, is a process of maturation. Since there is an increase in the total number of correct placements with increase in age it suggests that this may be a process of maturation.

Stern (11) presents the idea that the tactual-motor action may be an aid in the child's conception of spatial relations. In this study the child not only was able to see the easel with the ring in the proper place but also he was required to duplicate the configuration (to use Koffka's term) which he saw. This motor association with the visual perception may have helped to increase his ability to make a correct placement of the ring.

Results of the study are in close agreement to those found by Meyer in the experiment previously mentioned. In this study there was also a tendency toward error; the errors which were recorded were especially those of reversal of right and left side (symmetrical errors) and error in which the ring was placed in a position neighboring to the original.

Stern (11) in his discussion dealing with the child's sense of position says that in human beings the individuals own body is his center of space; thus one's conception of right, left, up, and down are in relation to one's own body. Trowbridge, however, states that young children do not use their own body as a center of space but that they use some external object as a point of reference. The data of this study seem to be in agreement with Trowbridge. In Positions I, VII and II where the child was not required to make any bodily turn there was a greater number of correct placements which may mean that the point of reference was consistant for these positions. In Positions VIII and IX where the child was required to make a complete turn of body in order to place the ring correctly we find a tendency for a much greater number of symmetrical errors. This may indicate that some external factor was used as an orientation cue for the correct placing of the ring. Thus when there was a complete turn of the body the reversal of right and left was the most frequent error. Here then is the tendency to put the ring on the same side of the easel as that on which the experimenter had her ring; thus the child was not able to make the distinction between right and left. The corner and marginal placements were decidedly easier than the inside placements. This may indicate that the children of this study used some external object as a point of reference rather than their own bodies.

Results of the study confirm the

statements which have been made in regard to the fact that young children distinguish between up and down earlier than between right and left. The classification of errors shows there are more errors made to the right and left than up and down. This fact may also be indicative of an external point as center of space which in this case might possibly be the floor.

That there is an ability for young children to adjust themselves to spatial relations is evident from the data of the study. That this ability is affected by change in bodily position is shown in data indicating that more correct placements were made in those positions where the child was not required to make any bodily turn. Those positions necessitating a turn of 360 degrees were the most difficult, while those requiring only a partial turning were between the extremes in difficulty. It would seem from this that the amount of turning affected the correct placement of the rings. Data seem to indicate by the number of errors made to the right and left that the child uses some point of reference external to his own body as a center of space. The fact that there are more errors made to the right and left in comparison to errors made up and down confirms the frequently made statements that the young child distinguishes between up and down earlier than between right and left.

SUMMARY

The purpose of this study was to determine the effect of bodily orientation upon memory for spatial placements of wooden rings on an easel designed for this experiment, and to note any factors which seem to influence ability to make successful placements.

Positions

The two most difficult positions were those which necessitated a complete turn of 360 degrees on the child's part; they were the situation in which the reverse side of the easel was used, and that in which the two easels faced each other. The easiest positions were those which required no turning of the child's body in order for correct placements to be made. The positions between the extremes in difficulty were those requiring the child to make a turn of 90 or 180 degrees. The reliability of the difficulty of the nine positions for the 32 subjects was .88.

There was a general increase with age in the total number of correct placements for the nine positions, although the increase was not equal or consistent between the age groups used in this study. The correlation between chronological age and the total number of correct placements is $.77 \pm .05$.

Since a reliability coefficient of .96 was found for the problem as a measure of the particular ability involved there may be an indication that bodily orientation is a special ability in the children used in this study. The correlation between mental age and the total number of correct placements is $.758 \pm .05$.

There were no significant sex differences found in the study.

Placements

Little difference in symmetrical errors to the right or to the left were evident; no symmetrical errors up and

down were made. There was a greater tendency to make errors to the right and left than to make errors up and down. A reliability of .936 was found for the difficulty of the twenty placements on the easel in the nine positions. The four corner placements were found to be the easiest and the marginal placements were next in difficulty, although the difference between the two were within the limits of chance. The inside placements were found to be decidedly the most difficult for the children of this study.

Conclusion

The data in this study indicates that change in bodily position does affect the memory for position of objects. This was shown by the decrease in the number of correct placements made in those positions which required either a partial or a complete turn of the body. The evidence is that the greater the amount of bodily change the fewer the number of correct placements.

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A Slide Rule for Calculating Ages[1]

JUNE F. CONSTANTINE

RARELY is a research problem completed in the field of child development and education without harking back to the arithmetic processes for changing years to months and months to days in which we were drilled so assiduously in the sixth grade. In fact, practically every field of research today takes into account the span of time as an important factor, whether it be for humans, animals, or inanimate objects.

The two main age problems which face the worker in child development are: (1) How old were these children on a certain date? (2) How old was this child on various dates? The slide rule to be discussed was constructed to solve either of these two problems with a minimum amount of time and error. Further research has shown that it can handle adequately many more.

Since the research worker generally uses a thirty day month, it is possible to use equal divisions on all the scales. In order to simplify the matter further, a table of yearly increments was devised. Table 1 is a section of this table. At first glance there is a consistent error of one year in this table. This was done purposely as the problem was then simplified into one of always adding the increment as shown on the instrument to the yearly increment. That is, two persons born on June 3, 1909, and December 4, 1909, respectively, would have on September 22, 1930, an age of twenty plus the amount on the scale. The increment added for the former would be 1 year, 3 months, 19 days; for the latter 9 months, 18 days. If actual year ages were taken the latter would have been 21 years (thirty minus nine) less 2 months, 12 days. However, it is generally accepted that consistent repetition of an act produces a mental set which is more conducive to accuracy and speed than the shifting back and forth between two activities.

TABLE 1

Yearly increments

YEAR OF BIRTH	YEAR OF MEASUREMENT					
	1929	1930	1931	1932	1933	1934
	Increments					
1922	6	7	8	9	10	11
1923	5	6	7	8	9	10
1924	4	5	6	7	8	9
1925	3	4	5	6	7	8
1926	2	3	4	5	6	7
1927	1	2	3	4	5	6
1928	0	1	2	3	4	5
1929		0	1	2	3	4
1930			0	1	2	3

[1] From the Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

Hence, it is better to add consistently since addition is the fundamental arithmetic process.

The calculator is made on the order of a very simple slide rule with four scales, two of which are on a center slide. In attacking a specific problem only two of the four scales are used at a time. Thus if one measures forty children on November 15, 1930, and wishes to record their ages, place an end point of the sliding scale above 11–15 on Scale A (fig. 1). This is all the setting the instrument requires. A child born on April 1, 1922, is 7 (1930 minus 1922 minus 1) years plus 1 year, 7 months, 15 days of age. To obtain the increment 1–7–15 look on Scale B above 4–1 (April 1) on Scale A. The point is midway between 1–7 and 1–8 or 1–7–15. A child born on March 23, 1906, is 23 (1930 minus 1906 minus 1) years plus 1 year, 7 months, 22 days. And so on for all children born before November 15. For those born after November 15, set the other end point of the slide above 11–15 (fig. 2) and proceed in a like

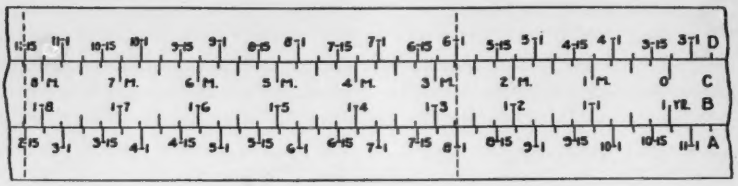

FIG. 1

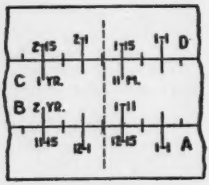

FIG. 2

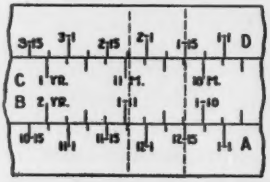

FIG. 4

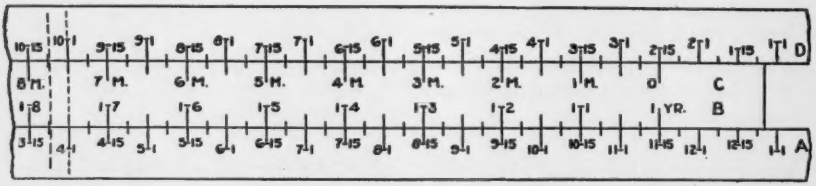

FIG. 3

manner using the increment from Scale C. A birth date of December 8, 1915, gives an age of 14 years plus 11 months, 7 days. If ages are desired only to the nearest month, one can tell at a glance on which side of the half mark the age will fall since 6 months, 15 days is 6 months, while 6 months, 16 days is 7 months.

Our second important problem is to ascertain the age of a given child on any day or days, or to discover when a child will have a required age. This might well come up in a study involving repeated measurements.

Take a child who was born on March 8, 1916. Set an end point of the sliding scale below 3–8 on Scale D (fig. 3). The child's age on June 1, 1920, as read from Scale B is 3 (1920 minus 1916 minus 1) plus 1–3 equals 4 years, 3 months; on November 15, 1926, 9 (1926 minus 1916 minus 1) plus 1 year, 8 months equals 13 years, 8 months respectively. The child's age on January 15, 1918, and February 6, 1930, will be found by setting the other end point under 3–8 (fig. 4) and taking the increment from Scale C. The ages would be 1 plus 10 months or 1 year, 10 months, and 13 plus 11 months equals 13 years, 11 months respectively.

One might well ask if this is an improvement over other methods of calculating ages. To date, the writer knows of only two other ways,[2] the arithmetic process and the Englehardt-White Age Calculator. The Englehardt-White Age Calculator is built to give ages to the nearest first of any month or as of September 1 or March 1. There are two sectors on a revolving scale, one for finding age as of September or March first and the correction to the month sector. Numerous tests have been conducted to discover their relative merits, from the standpoint of speed and accuracy. The subjects consisted of two staff members of professorial rank, two research assistants, one each from child development and psychology of music, two clerical assistants, and the author. With the exception of D, all the subjects were timed on the use of the slide rule ten or fifteen minutes after they had seen it for the first time.

TABLE 2

Comparison of the slide rule arithmetic and Englehardt-White calculator methods

SUBJECT	SLIDE RULE		ARITHMETIC		ENGLEHARDT-WHITE AGE CALCULATOR	
	Time	Errors	Time	Errors	Time	Errors
	minutes		*minutes*		*minutes*	
A	7	0	9	2		
B	12	0	12	2	15	6
C	11	1	20	1		
D	6	0	7	1	13	16
E	9	4	14	0		
F	25	4	13	11		
G	18	2	13	2		

Distribution of time required and errors made by each of seven subjects in computing forty ages by the methods listed is given in table 2.

The test consisted of a list of forty birth dates for which the age was to be computed for a given date, June 15, 1930. The birth dates were taken at

[2] Since this study was conducted the writer has found another age calculator, the Young Age Calculator, which calculates ages to the full month rather than to the nearest month.

random from record cards. June 15 was chosen since there would then be even chances of having to borrow months or days in using arithmetic.

The two tests of the Englehardt-White Age Calculator were made by persons who had used it a great deal and were familiar with its limitations. Even with the utmost care, however, it seems almost impossible to compute the ages accurately to a month.

A glance at the table will show that in over one-half of the cases the time was cut and the errors reduced when using the slide rule. The consensus of opinion of the last three subjects was that a little more practice in reading the scale would be a great help since they had never before come in contact with any type of slide rule. As it was, half of the errors in using the slide rule were made in obtaining the yearly increment incorrectly.

Even if there had not been a noticeable increase in speed and accuracy between using the slide rule and arithmetic in this short experiment, there would still be the question of efficiency over a protracted period of calculating. There is reason to assume that the fatigue point would be reached much later when using this device, just as in using other mechanical computing devices.

Some Conditions in the Dentition of Preschool Children

S. Idell Pyle and Charles L. Drain

During the last four years dental examinations have been made annually of those children who have attended the preschool laboratories of the Iowa Child Welfare Research Station. The examination included a notation of the number of teeth erupted and shed, inspection for cavities, fissures and abnormalities of the teeth, and an estimation of the general condition of the mouth. These data have been summarized to demonstrate the condition of the first dentition of the preschool child, and present another phase of the development to supplement that phase as previously described by their physical measurements (1).

One hundred and eighty-four boys and 189 girls were examined. The children came from homes where information and resources for proper health and dental instruction were easily available. They ranged in age from 18 months to 77 months inclusive. They were divided into age groups, the two-year age group consisting of those children between one year, six months, and zero days and two years, five months, and twenty-nine days. By this division the greater number of the children were in the four- and five-year-old groups.

The age distribution of children having examinations was as follows:

AGE	BOYS	GIRLS
years		
2	22	19
3	34	49
4	49	50
5	60	57
6	19	14
Total.....	184	189

ANALYSIS OF DATA

Eruption and shedding of teeth

At the outset examinations were made chiefly to advise the parents about the condition of the teeth already erupted. Hence, while the number of teeth erupted was recorded, no emphasis was placed upon the order of eruption. As the work progressed

TABLE 1

Mean number of teeth erupted at two and three years of age

AGE	BOYS		GIRLS	
	Mean	$P.E._M$	Mean	$P.E._M$
years				
2	17.41	1.68	16.16	0.38
3	19.59	0.89	19.61	0.94

this item was included, but not enough information has been collected to date to include it in this discussion.

All children in the four-, five-, and six-year groups had their first dentition. It is interesting to note that only 2 boys and 4 girls had shed any teeth by 6 years and 6 months of age. Seven boys and 7 girls had two or more of the first permanent molars erupted. The earliest age at which their eruption was noted was at 61 months.

Table 1 shows the mean number of teeth present at two and three years of age.

Ratios were computed to determine whether a sex difference in time of eruption existed. This ratio was calculated by dividing the difference between the mean number of teeth erupted by the probable error of the difference. A ratio of 3.0 or more was considered significant. The ratio was 0.38 for the two-year-old children, and showed that there was not a significant sex difference between the boys and girls in the age at which their teeth were erupted. Of the boys, 22.7 per cent had 20 teeth erupted, but only one girl had the first full denture. The difference between the three-year-old boys and girls was not significant, doubtless due in part to the fact that 82.2 per cent of the boys and 92.9 per cent of the girls had 20 teeth erupted. The youngest boy with a full complement was 27 months old and the youngest girl 29 months old. The oldest boy who had less than twenty teeth was 35 months old and the oldest girl 37 months old. The average age for the 23 boys having less than twenty teeth erupted was 27.78 ± 0.63 with a standard deviation

TABLE 2

Mean, standard deviation, and probable error of the mean of the number of cavities per child and the number of teeth affected, and the percentage of each age group having defective teeth

AGE	CAVITIES PER CHILD			NUMBER OF TEETH AFFECTED			DEFECTIVE TEETH
	Mean	S.D.	$P.E._M$	Mean	S.D.	$P.E._M$	
Boys							
years							*per cent*
2	1.00	2.73	0.38	0.73	2.04	0.29	18.2
3	0.91	2.31	0.26	0.73	1.79	0.21	23.5
4	2.16	4.10	0.39	1.55	2.71	0.26	42.8
5	5.75	6.33	0.52	2.33	4.55	0.40	73.3
6	3.94	4.22	0.65	2.79	3.39	0.52	68.4
Girls							
2	0.00	0.00	0.00	0.00	0.00	0.00	00.0
3	0.65	1.92	0.18	0.51	1.33	0.13	24.5
4	2.96	4.49	0.43	2.14	2.68	0.25	54.0
5	4.89	6.76	0.60	3.22	4.12	0.37	64.9
6	6.64	2.35	1.38	4.14	4.59	0.82	71.4

of 4.47 months and for the 27 girls 27.56 ± 0.69 with a standard deviation of 5.29 months. This difference in the age was not significant.

Supernumerary teeth

Supernumerary teeth were rarely found. Two boys each had an extra lateral incisor. No other anomalies in number of teeth were noted for the entire group.

Prevalence of cavities

In calculating the number of cavities the total number was considered as well as the number of teeth affected. This seemed pertinent, since often a tooth would have a break in the enamel in various parts of it without having a continuous defect of the entire surface. If only the total number of cavities was noted a somewhat spurious idea of defects in teeth could be deduced. Table 2 is a summary of these data.

The two- and three-year-old boys had a greater average number of teeth affected than did the girls, but in the three older age groups the reverse was true. At no age was the sex difference significant. The standard deviations were large. The percentage of chilDen in each group with no cavities indicated that the wide range was partly due to the fact that 50 per cent of the two- and three-year-old children had no cavities and 40 per cent of the four- and five-year-old children had none.

Sex differences in numbers of cavities

The four- and five-year-old groups of each sex were then considered together to see whether any consistent sex difference in number of cavities existed. One hundred and nine boys and 107 girls were compared. The boys had an average of 4.14 ± 0.39 cavities with a standard deviation of 5.95 cavities and the girls 4.04 ± 0.37 cavities with a standard deviation of 5.65 cavities. These figures are a rather interesting comment on the very bad dental condition found for some of these children since 41.3 per cent of the boys had no cavities and 40.2 per cent of the girls had none. The ratio of the difference between the means to the probable error of the difference again showed no significant sex difference.

TABLE 3

Percentage of total cavities located in each surface in each age group

AGE	SURFACE				
	Occlusal	Distal	Mesial	Lingual	Buccal
Boys					
years	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
2	22.7	18.2	50.0	0.0	9.1
3	45.2	9.6	29.0	6.5	9.7
4	55.7	14.4	18.3	4.8	6.7
5	44.3	20.1	28.4	1.9	5.2
6	54.7	26.7	16.0	0.0	2.6
Girls					
2	00.0	00.0	00.0	0.0	0.0
3	72.2	5.5	13.9	5.5	2.8
4	64.9	13.5	12.8	5.4	3.4
5	41.6	25.4	29.0	1.8	2.2
6	37.6	28.0	33.3	0.0	1.1

Location of cavities

The location of cavities was next considered. The total number of cavities in each of the five surfaces of the tooth were averaged to see which surface was the most frequent site of decay. For this summary the incisive

surface of the incisors and cuspids were called occlusal, and their labial surfaces were designated as buccal. The results are given in table 3.

cavities to distal and mesial was slightly greater for girls than for boys. The boys had more cavities in the buccal surface than did the girls.

TABLE 4

Mean per cent of cavities according to teeth in each age group

AGE	RIGHT TEETH					LEFT TEETH				
	Second molar	First molar	Cuspid	Lateral incisor	Central incisor	Central incisor	Lateral incisor	Cuspid	First molar	Second molar
	Mean per cent									
	Boys—Upper teeth									
years										
2	00.0	0.0	0.0	9.1	18.2	18.2	9.1	0.0	0.0	00.0
3	22.5	6.5	0.0	6.5	16.1	9.6	3.2	0.0	3.2	16.1
4	17.3	0.0	1.0	3.8	7.7	3.8	5.8	1.0	1.0	10.6
5	10.1	5.8	1.4	3.5	6.4	6.1	2.6	1.2	5.2	8.4
6	10.7	5.3	2.7	4.0	5.3	6.7	1.7	0.0	8.0	6.7
	Boys—lower teeth									
2	4.5	4.5	0.0	4.5	9.1	4.5	4.5	0.0	4.5	9.1
3	6.5	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0	6.5
4	14.4	6.7	1.9	1.0	1.0	1.0	1.0	1.0	9.6	10.6
5	11.9	7.5	0.8	0.6	1.2	1.2	0.3	0.8	11.6	13.0
6	2.7	9.3	1.7	0.0	0.0	0.0	0.0	1.7	24.0	10.7
	Girls—upper teeth									
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	15.6	16.7	5.6	0.0	2.8	8.3	11.1	0.0	0.0	16.7
4	16.8	5.4	2.0	2.7	5.4	4.7	0.7	0.0	6.1	14.8
5	10.7	5.0	0.7	4.3	6.8	6.1	3.6	1.1	8.6	11.1
6	9.7	11.8	3.2	6.5	7.6	7.6	3.2	1.1	10.8	8.6
	Girls—lower teeth									
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	8.3	11.1	2.8	0.0	0.0	0.0	0.0	0.0	0.0	16.7
4	13.5	7.4	0.7	0.7	0.0	0.0	0.7	0.7	5.4	12.1
5	10.4	8.9	1.1	0.4	0.0	0.4	0.7	1.1	9.6	9.3
6	6.5	8.6	2.0	0.0	0.0	0.0	0.0	1.1	7.6	8.6

Cavities were found most frequently in the occlusal surface, and next most frequently in the mesial and distal surfaces. The proportion of occlusal

The manner in which cavities were distributed in the teeth was investigated also. The molars were most often affected. In the small group of

two-year-old boys the upper central incisors were decayed most frequently, but in no other group were these teeth, which usually erupt first, the most frequent sites for caries. Table 4 shows their distribution.

Low attached frenum

A low attached frenum was not very prevalent. Cases were found scattered throughout all the age groups. This condition was present for 13.0 per cent of the boys and 16.4 per cent of the girls.

Fissures

Of the boys, 6.5 per cent and of the girls, 7.9 per cent had fissured teeth. With one exception, the defect always occurred in the molars.

Fillings

It was interesting to note the reaction on the part of the parents as to defects in the dentition. Usually repair of defects was optional with them. They were always notified immediately regarding the condition of the teeth, and urged to visit their own dentist. During the third year of the survey, an investigation was carried out to determine the amount of actual repair and prophylactic work done. Seventy-seven out of a group of 80 children had received adequate dental attention. But when the results from all four years are estimated together, less than one-fifth of the cavities were found filled when the dental examination was made. Of the cavities found 11.1 per cent of those of the girls were filled and 16.1 per cent of those of the boys. Fillings were noted in the molars a little more frequently than in the other teeth.

These results indicate to us two things, namely, the striking need for a program of dental health education whereby spontaneous parental interest in the condition of the child's deciduous teeth can be stimulated, and second a need for intensive investigation on the part of research workers into the specific effects of lack of repair and care of this denture on the health of the child.

Condition of the mouth of relation to cavities

The general condition of the mouth was rated as follows: clean, fairly clean, unclean, very unclean. Considering all the boys and girls together 22.4 per cent were rated as having clean mouths, 55.1 per cent as fairly clean, 21.1 per cent as unclean, and 1.3 per cent as very unclean. These ratings were made according to the presence of removable discoloration on the teeth, the need for general prophylaxis and the evidence of the kind of daily care and attention given to the teeth and mouth.

Finally, those children who had more than the average number of cavities were selected and their general mouth condition studied. This grouping was made by adding to the mean number of cavities found for each age two probable errors of the mean, in order to give a broader interpretation than that given by the mean value alone. There were 39 girls and 46 boys of whom 7.1 per cent had clean, 47.1 per cent fairly clean, 41.1 per cent unclean, and 4.7 per cent very unclea mouths.

It is true that this estimation of mouth condition was based upon one examination. The evidence points to the need for better care of the mouth in young children, even if this analogy does not present a clearly defined relationship between occurrence of cavities and general condition of the mouth.

SUMMARY

Dental examinations were made of 184 boys and 189 girls ranging in age from eighteen months to seventy-seven months who were in attendance at the preschool laboratories of the Iowa Child Welfare Research Station. The investigation revealed:

1. That 40 per cent of the two- and three-year-old children were 27-months-old before the first dentition was completed.

2. That there was no sex difference in the number of cavities found.

3. That cavities occurred most frequently in the occlusal surface of the tooth, and next most frequently in the mesial.

4. That the molars had the greatest number of cavities and that the upper teeth were affected more frequently than the lower.

5. That the relationship between general condition of the mouth and occurrence of cavities could not be clearly demonstrated.

6. That the need for dental health education particularly at this age is clearly indicated.

REFERENCE

(1) IOWA CHILD WELFARE RESEARCH STATION: Physical traits of young children. Amer. J. Dis. Child., 1929, **38**, 541–546.

A Cold Light for Photographing Infant Reactions with the High-Speed Motion Picture Camera[1]

ORVIS C. IRWIN

IN PROJECTING a series of photographic studies of the reactions of newborn infants with a high speed motion picture camera, some difficulties in securing adequate illumination were encountered. A special technique had to be devised for this work, since the requirements for illumination are somewhat different from those ordinarily used. These requirements are: (1) sufficient intensity at high speeds of the camera to photograph very rapid infant movements, (2) absence of heat to avoid burning the skin of the infant, (3) elimination of rays injurious to the infants' retinas, (4) constancy of illumination for extended periods, (5) adaptability to the experimental situation (in this case to an experimental cabinet).

After a series of trials it was found that incandescent lights using high wattage and a special surgical lamp failed to meet the requirements. The incandescent lights gave off too much heat at intensities needed for adequate illumination at the high camera speeds. The surgical lamp although it was equipped with a water cell to absorb heat, was too awkard to manipulate in the cabinet in which the infants are photographed.

A neon light was devised to meet the requirements of photographing the movements of newborn infants without injury. It consists of two neon grids[2] made of lead glass tubing, one of which furnishes the greater amount of illumination, and a second smaller grid which gives enough light to eliminate shadows cast by the first. The main grid is constructed of 16 feet of 10 mm. tubing bent into seven parallell sections and is mounted on a mirror 12 inches by 28 inches. It is suspended at a 45 degree angle by adjustable levers 15 inches above and to the right of the infant. The second grid is made of 12 feet of 8 mm. tubing bent into five parallel sections. It is mounted on a mirror 9 inches by 28 inches and is suspended on the left side of the infant. Both grids are equipped with standard neon sign electrodes which are connected at opposite corners to the grid in order to avoid sparking. The tubes are filled

[1] From the Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

[2] The feasibility of using the neon grid for work with infants was suggested by the successful photographic use of a neon time light by Dr. Joseph H. Tiffin. Department of Psychology, State University of Iowa, Iowa City, Iowa.

with a gas mixture commercially known as Airco B-10 to which mercury has been added. The gas pressure within the tubes is 10 mm. of mercury. The tubing is made of lead glass, a Corning Glass Company product known as Gl. The large grid is operated by a 15,000 volt neon sign transformer having a secondary current of 30 milliamperes. The smaller grid is operated by an 8,750 volt transformer giving a secondary current of 23 milliamperes. The accompanying photograph shows the illuminated grid.

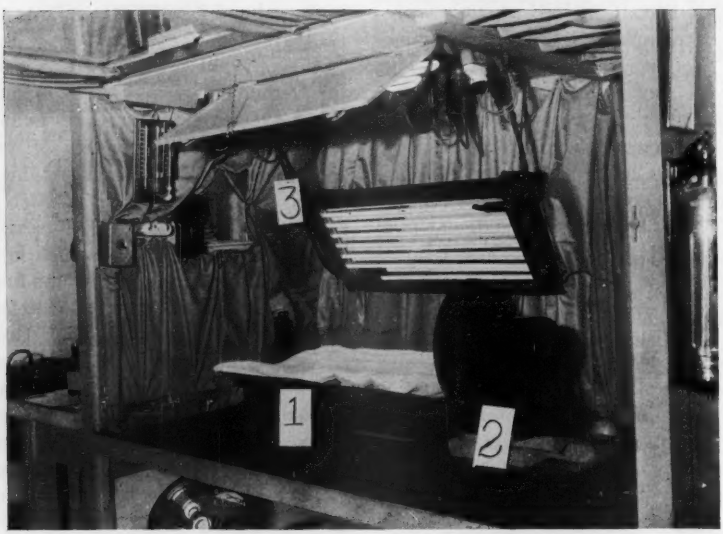

FIG. 1. SHOWING NEON LIGHT GRID (NO. 3) INSTALLED IN EXPERIMENTAL CABINET

The illumination provided by this light is sufficient to take motion pictures at the rate of 32, 52, or 72 pictures per second of infant reactions too rapid in their motion to be followed by the eye. The appended samples of film taken at these rates show the degree of clearness of each. The requirement of a heatless light, so important in work with newborns, is successfully met by the B-10 mercury light. The glass is barely warm to the touch and at five inches no heat can be felt. The Airco B-10 mixture when used without the addition of mercury shows a spectrum in which the predominating lines are those of argon. The emission under these circumstances will be comparatively little in the ultra-violet region. If the mixture is used with mercury, the mercury lines will predominate in the spectrum, showing some radiation in the ultra-violet region. However, the use of a high grade of lead glass in the tubing insures the elimination of injurious

ultra-violet radiation. The constancy of illumination, it was found, depends upon the length and size of the tubes, and upon the voltages impressed on the electrodes. With transformers of the voltages indicated, flicker is eliminated. The grids as designed can be installed and easily manipulated in a limited space such as is afforded by the experimental cabinet.

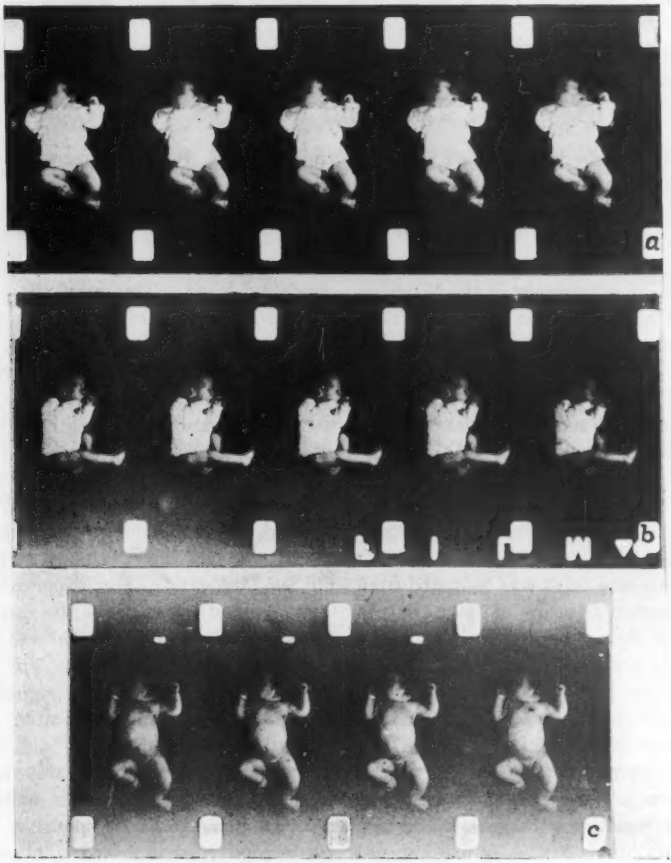

FIG. 2. ENLARGEMENTS OF FILM: (*a*) 32 PICTURES PER SECOND; (*b*) 52 PICTURES PER SECOND; (*c*) 72 PICTURES PER SECOND

Brief Reports

The Effects of Practice in Tracing the Porteus Diamond Maze*

THIS study is concerned with the effects of specific practice upon the ability of young children to trace the Porteus Diamond Maze. The subjects were 24 children ages 24 to 40 months in attendance at the Washington Child Research Center. They were first given an initial test on the maze consisting of 2 trials with each hand. The performance was scored by a method similar to that reported by Baldwin and Stecher (1). A diamond model of isinglass divided into 44 equal segments was superimposed upon the child's traced diamond. For every segment in which the child's line left the maze one point was deducted from the maximum score of 44. On the basis of the average of the two scores with the preferred hand (the hand with which the best score was made) two groups of children were formed, so that the mean score of each group was 23.0 and the standard deviation 15.1. The two groups were also made approximately equal in average age and age distributions.

The 12 children in the practice group repeated the test (a test consisting of 2 trials with the preferred hand only) 7 times. On account of absences not all tests could be given at exact intervals, but in general a weekly interval was maintained. Both groups were then given 2 end tests on the maze. The first end test was the same as the initial test—2 trials with each hand—while the second consisted of 2 trials with the preferred hand. This gave the practice group a total of 20 tracings with the preferred hand and 4 with the non-preferred. The control groups traced the maze 6 times with the preferred hand and 4 times with the non-preferred.

The instructions to the child in each case were "See, here is a game. We go around this road trying to stay inside these two black lines. Be just as careful as you can." The experimenter drew around the maze as the instructions were given and the child was then given an unmarked copy. For the second trial on each practice period the experimenter merely presented the child with a new maze and said: "Go around the road and try to stay inside the two black lines." The children were coöperative and responsive. As far as could be determined by observation the children in the practice group continued throughout the experiment to look upon the maze tracing as a game which they enjoyed playing.

RESULTS

Table 1 and figure 1 show that both the practice and control groups made

* From the Washington Child Research Center.

large gains in average scores. The average score of each group on the initial test was 23.0. On the first end test the average score of the practice group was 30.2, a gain of 7.2. The average for the control group on the same test was 31.1, a gain of 8.1. The control group therefore gained 0.8 more than the practice group on the first end test. On the second end test the score of the control group surpassed that of the practice group by 0.3. These small differences between the two groups are not significant. The gains of each group are large, however, and so consistent for individuals—20 children gained on the first end test, 3 retained a zero score and 1 scored lower than on the initial test—that they may reasonably be considered as significant gains. The indication of these results is that the specific practice of the amount and kind given the practice group did not result in a significantly greater increase in skill than the increase found in the control group. The large increase in skill in both groups may be attributed mainly to

TABLE 1

Average scores on Porteus Diamond Maze

GROUP	I	1	2	3	4	5	6	7	E-1	E-2
Practice	23.0	27.2	24.4	27.9	26.2	27.7	29.7	29.4	30.2	31.8
Control	23.0								31.1	32.1

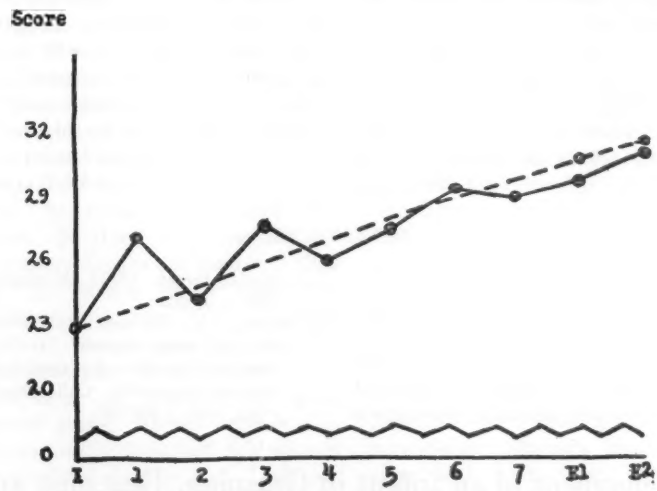

FIG. 1. AVERAGE SCORES ON PORTEUS DIAMOND MAZE
Practice group ———, control group – – – –

factors such as structural maturation and general practice. These results are in accord with the findings of 2 experiments previously reported (2, 3).

Each child traced the maze twice during each test period. The effects of practice within these test periods was found by comparing the average score for the first trial on all tests with a similar average for the second trial. The average of all first trials was 27.6 and of all second trials 28.3. The difference of 0.7 in favor of the second trial is an indication that the children did slightly better on the second of 2 successive trials.

Table 2 shows that the difference between the average scores with the preferred and non-preferred hands on the initial test was 3.2 for the practice group and 6.0 for the control. On the end test this difference was 12.0 for the practice group and 8.5 for the control. For the combined groups the difference in scores on the two hands was 4.6 on the initial test and 10.2 on the first end test. The difference in skill between the preferred and non-preferred hands thus increased markedly over the period of time covered by this study.

TABLE 2

Average scores on Porteus Diamond Maze with preferred and non-preferred hands

GROUP	INITIAL TEST			END TEST		
	Preferred hand	Non-preferred hand	Difference	Preferred hand	Non-preferred hand	Difference
Practice	23.0	19.8	3.2	30.3	18.3	12.0
Control	23.0	17.0	6.0	31.1	22.6	8.5
All	23.0	18.4	4.6	30.7	20.5	10.2

J. Allan Hicks,
Dorothy W. Ralph.

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Development of an Infant in Grasping, Reaching and Body Movements

DAY 1. At two hours, grasping reflex strong when palm of hands touched. 10. Grasping reflex less strong. 71. Grasps ribbon hung across crib, sometimes with thumb opposed. At times grasps rattle fastened to ribbon. Holds rattle with right hand, by its ring, and shakes at times. 78. Grasps rattle with one or both hands, thumb opposed. Uses right hand especially. 104. Grasps spoon with left hand (nearest hand) and cup with right (nearest), when fed orange juice. 124. Takes hold of breast and pulls to

mouth. 147. Picks up toys seen, or felt in fumbling. Thumb opposed to fingers. Not always successful at first trial. Takes hold of spoon when fed orange juice or water; guides to mouth with one or both hands. 169. Reaches with both hands toward toys, dishes, etc. If one hits hand, closes fingers of both hands. Often in awkward position, such as object between two fingers. 176. Reaches for objects as small as a bead one third inch in diameter. Picks up by pushing fingers against palm.

ARM AND REACHING MOVEMENTS

Day 1. Yawn twenty minutes after birth, with stretching of arms. Random arm movements. 10. Stretches both hands above head. 15. Vigorous arm movements during bath. 19. Feel breast and clothing with fingers and palm. Sometimes one hand, usually both. 21. Lying awake, threw arms about. 24. Hands often together, fingers intertwined or one hand over other fist. 25. Hands clutch bedclothes, mother's dress, etc. Pull. 27. Rash on face. Throws arms about but seldom hits face. When strikes it, rubs with fists. 30. Reached for spoon several times, random fashion. 31. Hands usually outspread, held up over head when sleeping. 32. Definitely brings fist to mouth. 34. Pulls covers over face and sometimes cries when covered. 36. Hands pushed away bottle after "trial and error." 42. Uses hands at random, but right with greater force. Pushes bottle away. 45. Fewer random movements. 50. Reached toward towel. Pulled over face. Once reached toward white tub and smiled. Fumbles at breast and clothes of mother during nursing. Pushes spoon away with hand on side from which spoon given, other hand at same time motionless or in less motion. 59. Uses hands constantly when awake, especially pulling at bedclothes. Pushes down with hands when turned on stomach. Rubs eyes at times when sleepy. Both fists or one. Usually both arms moving. 64. When wakes in morning, is very quick in movements of arms. 71. When rattle suspended before baby, movements toward it random. 78. Rattles rattle much of waking time, usually by thrashing arms but sometimes by grasping rattle. 92. Plays with rattle, handles spoon and other objects with both hands, coördinated movement though uncertain aim. Reaches for mother's glasses and pulls off. Much random thrashing present also. At times, splashes in tub. 99. Feels one hand with other. 104. Reaches toward objects: rattle, doll, bathtub, and toilet articles, crib-cover clamps, blankets. Sometimes reaches for breast and pulls toward mouth. Both hands used. Holds armsacross shoulders of person carrying. Rubbed ear after it was cleaned, with hand on that side. Hand carried directly to ear without preceding false movements. Mother's hand pushed away with both hands on second attempt to cleanse eyes with boric acid. 120. Reaches for toes. Wiggles them and watches, especially in bath. 124. Crackles paper in two hands, pulls to mouth. Pushes spoon away when orange juice given. 135. Reaches rather aimlessly still, but less so with time. 140. Transferred rattle from one hand to other with dexterity. 147. Holds toys, celluloid or soft cloth, and

crinkles and tears paper. 156. In reaching, aim rather direct but not always certain. Plays with aluminum dish cover. Pulled off cap today. Often pulls at head when cap on. Pulls off stockings and mittens. Throws right arm about in a circle. 168. Holds toy in one hand and reaches with other for another object. But tendency for hand holding toy to reach out too. 169. Given spoon, pounded on table. Dropped. Fretted and leaned over toward place where dropped. Mother handed back spoon and baby threw it and laughed. 176. Throws rattle on floor from crib but never throws other toys. Sometimes drops them. Holds two toys, one in each hand, but if holding one, drops it to get another held out to her.

BODY MOVEMENTS

Hitching and crawling

Day 59. When turned on stomach, position almost as if creeping. 104. Hitches up in crib until head hits top, when lying on back. Even more marked in carriage, where baby can push with bottom of feet. 124. Pushed across table one foot, toward milk bottle, and tipped over bottle. Whole body pushed sidewise, lying on back. 156. Crude creeping position when placed on stomach. On back, hitches shoulders and hips and moves backward quite fast.

Sitting

Day 92. In tub, pushes with feet until almost sitting up. Pushes same way in mother's lap until sitting, supported at back. Scarcely needs support. 107. Sat up in bathtub, holding on sides with two hands. Sat up when weighed for brief time. Then mother put in crib with pillows around, and baby sat up five minutes playing with toys and laughing. 113. Sits up more, supported by arm or pillows. 126. preference for sitting position, in carriage or lap. Propped up in carriage, suddenly sat upright without support, reached forward for toes, then lost balance and fell forward. Caught by mother. 135. Sat one half minute without support. 140. Sits up suddenly in carriage when propped in semi-sitting position. Can sit alone, but mother props with pillows for safety. Cannot sit up when put down on back, but raises head and feet. 156. sits alone, leans forward for toys and pushes back up. But when falls to side, frets to be helped up. Often drops forward, leaning on hands.

Turning

Day 59. Turns over from side to back, and sometimes all the way over. 64. Turns from side to side, or to back during sleep. 166. Turns completely over when on hard surface. Throws body in direction of object reached, when reaching, without regard for balance.

FLORENCE WOOLSEY HAZZARD.

Tower Building

THE cubes ordinarily used in tests of tower building are fairly large. For a more precise measurement of the child's ability to build towers the one-half inch cubes and cylinders included in Mrs. Hailmann's Beads No. 470 of Bradley's Kindergarten Material were used.

The child was seated at a small table upon which the blocks to be used were placed. He was told to build a tower as high as he could. The observer demonstrated the building then placed the blocks back in the group. If the child stopped after a few blocks were placed he was encouraged to put other blocks on. A record was kept of the time taken for the building and of the number of blocks placed. The cubes were presented first. After a brief interval for changing blocks the cylinders were presented. This procedure was repeated after an interval of a month. The reactors included 25 children ranging in age from twenty-nine to sixty-one months, and 9 adults who were graduate students.

In table 1 the scores are given for the number of blocks placed and for the time required in the placing. The largest number of cubes placed by an adult was 12 but one child succeeded with 13 cubes. No adult placed fewer than 10 cubes and 2 of the youngest children succeeded in placing only 4 cubes. This wide range of placements for the children gives them an average of 8.2 cubes placed in comparison with 11.4 for adults. The time required is a function of the number placed though wide differences in time required for the same number of blocks are found. The range of time scores for adults is from 18 seconds for 10 cubes to 41 seconds for 12 cubes; for children from 7.4 seconds for 4 cubes to 178 seconds for 13 cubes. Despite three long time scores the children show an average time of 38.1 seconds to be compared with 27.3 seconds for adults.

The cylinders offered greater difficulty to both groups. The ability of the children in number of cylinders placed and in time required approaches more closely the adult performance than with the cubes.

The second trials by the children show an improvement in the time required for the cubes but approximately the same average for number placed. For the cylinders the time required is slightly longer than on first trail and the average for placements is slightly higher.

It would seem advantageous for the differentiation of abilities of children that the larger blocks frequently used in mental measurements of children under 6 years of age should be replaced by smaller ones. The limitation of the number to be placed to less than 10 does not offer an opportunity to the child of superior skill to display his abilities.

BUFORD JOHNSON,
DOROTHY MOORE COURTNEY.

TABLE 1

Tower building

CHILD	CHRONOLOGICAL AGE		TRIAL 1				TRIAL 2			
	Years	Months	Cubes		Cylinders		Cubes		Cylinders	
			Number	Time	Number	Time	Number	Time	Number	Time
1	4	8	11	30	6	30	10	35	8	125
2	5	0	9	19	4	6	10	28	5	14.4
3	4	5	8	18.6	5	14.2	7	18	5	24
4	4	4	9	23	4	8.2	11	34.8	6	14.4
5	4	4	10	29	6	14	6	16.2	5	15
6	4	10	13	178	8	52.4	13	82.4	9	44.6
7	4	5	10	42	5	14	9	21.6	5	10.8
8	4	9	7	20.2	6	22.2	6	16.8	4	18
9	3	7	6	12	6	16.6	6	15.4	6	16
10	4	3	12	39.2	5	7.8	11	46.4	8	55
11	4	7	6	14.4	5	11.4	7	28	6	19.8
12	3	8	9	81.4	7	30.2	9	60.6	5	19.8
13	4	10	8	17.4	5	14.4	7	20.2	6	10.6
14	4	0	7	31	6	17.2	9	63.6	5	17
15	3	10	9	52.2	5	15	9	35	5	10
16	3	10	9	41	6	15.4	11	57	5	19.4
17	5	1	8	18.8	5	10	9	30	8	21
18	4	3	7	20.2	7	33.8	7	17	6	15
19	2	8	8	35	5	29.2	5	81	5	36.2
20	2	8	4	24.2	4	32.2	9	47	5	31.4
21	3	0	8	47	5	20.6	6	17.4	4	8.4
22	2	5	4	7.4	3	63.4	5	11	7	7.2
23	4	2	11	54.6	4	6.4	8	52	5	12
24	3	6	7	90	6	26.2	8	40	5	25
25	3	4	5	11	4	11.6	5	9.8	4	6
Average.....			8.2	38.1	5.28	20.6	8.18	35.1	5.5	23.6
ADULTS										
1			12	41	8	40				
2			10	26.8	5	16				
3			12	24	7	16				
4			12	25	7	15				
5			11	20.4	8	14				
6			10	18	6	11.2				
7			14	31	7	19.8				
8			12	36.8	9	30.8				
9			10	23.8	5	10				
Average.....			11.4	27.3	6.8	19.1				